The application of habit theory to oral health behaviours

Thesis submitted in accordance with the requirements

of the University of Liverpool for the degree of Doctor in Philosophy by

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Abstract

A habit is defined as a process by which a stimulus generates an impulse to act as a result of a learned stimulus-response association. This thesis presents the novel application of habit formation theory to the dental context, to help determine how it might be applied to both frequent (predominantly tooth brushing behaviour) and relatively infrequent behaviours (preventive dental visiting). Study 1 reports a systematic review on the effectiveness of cue-automaticity interventions to increase preventive healthcare attendance and how this might then be translated into a dental setting. The study concludes that although limited work has been conducted in this area, initial findings are encouraging. Study 2, a qualitative study, explores the theoretical proposition that established tooth brushing behaviour may become habitual (and therefore automaticity performed). Key components to habitual tooth brushing behaviour are described and differences between morning and evening brushing investigated. Study 3, a cross-sectional survey, explores the psycho-social characteristics associated with habitual tooth brushing and interdental cleaning behaviours across the socio-economic spectrum. Results showed tooth brushing as performed habitually, with automaticity scores associated with age, gender and self-efficacy for tooth brushing while automaticity scores for interdental cleaning were associated with intention to perform the behaviour. Study 4, a habitual tooth brushing intervention development piece, begins to explore how a habitual tooth brushing intervention could be delivered to vulnerable populations (e.g. those with unstable routines or pregnant women). This thesis significantly adds to the literature in this new area by giving empirical evidence of the habitual nature of tooth brushing behaviour, identifying variables associated with this habit and informing the development and testing of future interventions.

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Finally, I would like to dedicate this thesis to my mum, Ann, who I love very much.

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Abbreviations

II	Implementation Intention
IMD	Index of Multiple Deprivation
NHS	National Health Service
NICE	National Institute of Clinical Excellence
PHE	Public Health England
RCT	Randomised Controlled Trial
SES	Socio-economic status
SRBAI	Self-reported Behavioural Automaticity Index
WHO	World Health Organisation

Chapter 1: Introduction

1.1 Introduction

This chapter provides an overview of the context within which this thesis is set. It gives a synopsis of reasons for the application of the key theoretical model (habit theory) used. The chapter also discusses the thesis structure as well as setting out the four key research questions which framed this research piece.

1.2 Background

Global oral health remains suboptimal. Whilst a decline in dental caries has been noted, due in part to the introduction of fluoridated toothpaste (Petersen & Kwan, 2010; Marthaler, 2004; Bratthall, Hänsel-Petersson & Sundberg, 1996; Petersson & Bratthall, 1996; Sheiham, 1984), dental caries still represents a significant global burden across both developed and developing countries (Kassebaum et al., 2017; 2015; Bagramian, Garcia-Godoy & Volpe, 2009; Petersen, 2003). Indeed, it has been reported as the most prevalent condition experienced in adults (Kassebaum et al., 2017). Its prevalence within children also remains alarmingly high, particularly within low socio-economic and ethnic minority groups (McLaren et al., 2016; Schwendicke et al., 2015; Kramer et al., 2014; Broomhead et al., 2014; Ottawa, 2010; Do et al., 2010; Armfield, Spencer & Slade, 2009; Edelstein & Chinn, 2009). In addition, periodontal disease also maintains at unacceptably high levels (Tonetti et al., 2017; Jin et al., 2016; Marcenes et al., 2013). Individuals with periodontitis are at increased risk of tooth loss, which may result in multiple extractions or even edentulism (Chapple et al., 2015; Chapple, 2014; Petersen & Ogawa, 2012).

Poor oral health can have a significant negative impact on people's lives in a number of different ways. For example, it can 1) affect an individual's ability to speak and / or chew and can alter the taste perception of food, resulting in food avoidance (Ástvaldsdóttir et al., 2018; Gilchrist et al., 2015; White et al., 2012; Savoca et al., 2010; Goes et al., 2008; Chalmers et al., 2008; Locker & Grushka, 1987); 2) can lead to disturbance of sleep with as many as 27% of adults' nationally experiencing dental pain (Pau, Croucher & Marcenes., 2007); and 3) has a significant negative economic and societal impact due to absenteeism from work or school due to dental pain and /or attendance of emergency dental appointments (Listl et al., 2015; Jin et al., 2015; Hayes et al., 2013; Guarnizo-Herreño & Wehby, 2012; Jackson et al., 2010; Petersen, 2003; Gift & Atchison, 1995).

Importantly, having poor oral health is almost entirely preventable. Simple oral health behaviours such as regular twice daily tooth brushing, with a fluoridated toothpaste, and interdental cleaning can significantly reduce dental caries and improve periodontal health (Zimmermann et al., 2014; dos Santos, Ndanovsky & de Oliveira, 2013; Poklepovic et al., 2013; Frencken et al., 2012; Buzzalaf et al., 2011; Wong et al., 2011; Saxlin et al., 2011; Imai et al., 2011; Al Habashneh et al., 2010; Han et al., 2009; Ishak et al., 2007). In addition, more complex behaviours, such as preventive dental visiting are also important to help in the establishment of good oral health (Broadbent et al., 2016; Almoznino et al., 2015; Åstrøm et al., 2014; Montero, Albaladejo & Zalba, 2014; Palėncia et al., 2013; Crocombe et al., 2012; Thompson et al., 2010; Watts & Meenan, 2002; McGrath & Bedi, 2001). As a result, both national and international attention continues to be given to how oral health behaviours, such as twice daily tooth brushing, interdental clean and preventive

dental visiting, can be established and maintained, to help reduce the incidence levels of oral disease (Sgan-Cohen et al., 2013; Pitts et al., 2011; Sheiham et al., 2011; Petersen & Yamamoto, 2005).

The mainstay of behavioural change efforts within the dental context remains within one-to-one interventions, predominantly delivered within the dental context. In recent years, there has been a move away from traditional education only oral hygiene (tooth brushing and interdental cleaning) interventions for behavioural change. This is due to the lack of evidence of effectiveness and long term sustained change of behaviour (Gao et al., 2014; Kay & Locker, 1998). At the same time, there has been an increase in interest in psychological interventions for oral hygiene instructions since emerging evidence shows positive results of effectiveness (Newton & Asimakopoulou, 2015; Gao et al., 2014; Brand et al., 2013; Stenman et al., 2012; Suresh et al., 2012; Godard et al., 2011; Renz et al., 2007).

1.3 Scope of the thesis

The application of theoretical models to behavioural change interventions has been reported to produce a more effective intervention (Conner & Norman, 2017; Prestwich, Webb & Conner, 2015; NICE, 2015; Webb et al., 2010; Glanz & Bishop, 2010; Michie & Abraham, 2004; Hardeman et al., 2002). In a novel and innovative way, this PhD focuses on how habitual theory can be applied to the dental context in order to help establish desirable oral health behaviours. Establishment of habitual behaviour is advantageous for a number of reasons including: 1) behaviour is performed via automatic processing (Gardner 2012; Lally et al., 2010; Wood & Neal, 2009; Verplanken & Wood, 2006); 2) behaviour continues to be performed even

when motivation and intention wane (Neal et al, 2011; Lally, Gardner & Wardle, 2011; Gardner et al., 2011; Wood & Neal, 2009; Hall & Fong, 2007; Weinstein, 2007; Verplanken & Wood, 2006; Triandis, 1977); and 3) habitual behaviour has been shown to result in behaviour maintenance in the longer term (Kwasnicka et al., 2016; Rothman, Sheeran & Wood, 2009; Rothman, 2000).

1.4 Thesis outline

Overall, the theme of this PhD is to begin to explore how habit theory can be applied to clinical dentistry. The thesis has been organised in sequence of the studies performed, as each study contributed to the development of the next. Each chapter for each new study starts with an overview of the need/rationale for the study, followed by a method, result and discussion section.

Chapter 2 (the literature review chapter) discusses in depth, theoretical models for behavioural change and maintenance, the importance and significance of establishing good oral health as well as discussing the main interventions applied within the dental context. The second half of the chapter discusses in detail, the literature around habit including the theory of habit formation, habit measurements, habitual interventions to health and finally the application of habit theory to the dental context.

Chapter 3 (study 1) is a systematic review which reports on the application of habit theory to infrequent health behaviours and focuses on addressing the question: can cue-automaticity interventions be used to establish desirable infrequent behaviours (i.e. preventive dental care usage)? By looking across the healthcare spectrum, it

explores how this approach has been attempted within other healthcare disciplines, and how this could be translated into the dental context.

Chapter 4 (study 2), a qualitative study, explores the nature of tooth brushing behaviour to address the research question: is tooth brushing behaviour habitual in adults? And if so, what are the cues (prompts) and motivators/rewards (drivers of behaviour repetition) for initiation of tooth brushing and its maintenance?

Having established that tooth brushing behaviour is habitual from study 2 (chapter 4), chapter 5 (study 3) then explores, via a cross-sectional survey, the self-reported automaticity levels of oral hygiene behaviours (tooth brushing and interdental cleaning) to understand how generalisable this may be for the population. It also explores the impact of various participant characteristics (such as personal routine preference) on the establishment of automatic oral hygiene behaviours.

This leads on to chapter 6 (study 4), a habitual tooth brushing intervention development piece, which begins to explore how habitual tooth brushing intervention might be delivered to vulnerable populations (e.g. those with unstable routines or pregnant women).

Finally, chapter 7 concludes this thesis by answering the four research questions (see section 1.4.1) by drawing together all the evidence from each study. A reflective section also reports constructive criticisms to some of the work conducted. This chapter concludes by making recommendations for practice and future research.

The following flow diagram outlines the thesis and how the findings from the previous study lead to the conduct of the next.

Study 1: Systematic review of the effectiveness of interventions using a mechanism of cue-automaticity to increase the uptake of preventive healthcare services, together with the review paper by Gardner (2015), synthesised the current literature on habit theory application to healthcare. This included both frequent (Gardner, 2015) and infrequent (Study 1) behaviours.

Having reviewed the current literature, this posed the following unanswered question: What is the nature of tooth brushing behaviour in adults? To answer this question, the next study within the thesis was conducted.

Study 2: A qualitative study to identify the nature of tooth brushing behaviour. This identified tooth brushing as having a habitual nature, i.e. performed automatically without cognitive effort.

The findings of this study posed further questions to be addressed, such as, how generalisable is habitual tooth brushing behaviour across a wider population? Is tooth brushing always more habitual in the morning compared to the evening? What are some of the key individual characteristics which may influence the level of automaticity able to be achieved for tooth brushing behaviour? To address these questions, the next study within the thesis was conducted.

Study 3: Cross-sectional survey to explore the automaticity of oral hygiene behaviours.

The results of this study added empirical evidence to the habitual manner of both morning and evening tooth brushing behaviour. It also highlighted the association between tooth brushing automaticity levels and age, gender and self-efficacy.

Leading on from both study 2 and study 3 which demonstrated the habitual nature of tooth brushing behaviour, the following questions were presented to be addressed; could this theory be applied to develop a habitual tooth brushing intervention? What should the intervention include? What are the important components to the intervention from a participant perspective? The final study within the thesis helped in addressing these questions.

Study 4: Tooth brushing intervention development in vulnerable populations.

This study was conducted in two parts:

Study 4a: Involved developing a tooth brushing intervention with individuals who may be likely to be vulnerable to oral disease due to their unstable or variable routines, delivered outside the healthcare setting.

Study 4b: In contrast, this part of the study involved individuals who are likely to be vulnerable to oral disease due to their current health status, delivered within a healthcare setting.

1.4.1 Research questions

At the outset of this thesis four research questions were set, namely:

1. Do cue-automaticity interventions have a place in preventive healthcare for adults?

2. Could these types of interventions (cue-automaticity) translate into the dental context?

3. What is the nature (habitual/automatic or cognitive/considered) of tooth brushing behaviour?

4. If tooth brushing behaviour is habitual, can a habitual tooth brushing intervention be developed and delivered?

1.5 Conclusion

Therefore, this thesis significantly extends knowledge around the application of habit theory to the dental context. Specifically, it gives empirical evidence of the habitual nature of tooth brushing behaviour, provides data identifying variables associated with this habit and informs the development and testing of future interventions.

Chapter 2: Literature Review

2.1 Overview

With both national and international attention increasingly focused on strategies to improve oral health (Sgan-Cohen et al., 2013; Petersen & Yamamoto, 2005), and self-directed behaviours such as tooth brushing with a fluoride toothpaste shown to be criterial in maintaining good oral health (dos Santos, Ndanovsky & de Oliveira, 2013; Frencken et al., 2012; Buzzalaf et al., 2011; Wong et al., 2011) a lot of research attention has been directed at gathering evidence to support the establishment and subsequent maintenance of healthy behaviours. Therefore, the following section begins by exploring oral health behaviours and the important theories for behavioural change and behavioural maintenance.

2.2 Health behaviour and behavioural change theory

One broad definition of health behaviour defines it as "an overt behavourial pattern, action and habit that relate to health maintenance, to health restoration and to health improvement" (Gochman, 1997, pg3) and this can be applied to the oral context. Oral health behaviours may best be considered to occur across a spectrum ranging from simple to complex behaviours (Plsek & Greenhalgh, 2001). For example, dental visiting might be considered to have more external (environmental) influences related to the service accessibility in comparison to other oral health behaviours such as tooth brushing, which is more within the control of individuals. This means that feedback loops are of greater significance and puts dental visiting at the more complex end of the oral health behaviour spectrum.

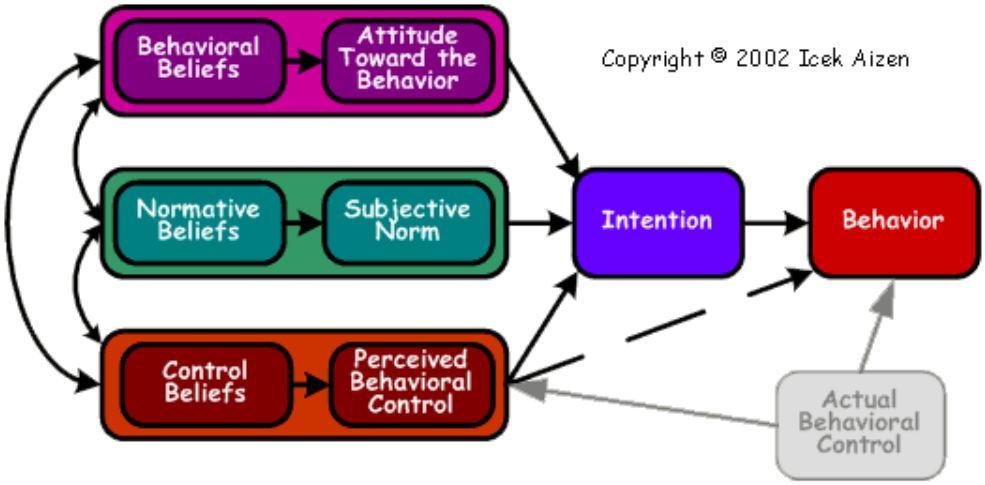
The application of theory to interventional development has been demonstrated to result in more effective interventions and therefore the application of theory to intervention design is encouraged (Conner & Norman, 2017; Prestwich, Webb & Conner, 2015; NICE, 2015; Webb et al., 2010; Glanz & Bishop, 2010; Michie & Abraham, 2004; Hardeman et al., 2002). However, the application of theory to interventions is often inadequate or theories are ineffectively integrated, influencing the level of effectiveness reported (Prestwich, Webb & Conner, 2015).

Numerous theories and models of behavioural change have been proposed to help assist understanding of behavioural change. These include, but not limited to, the Theory of Planned Behaviour (Ajzen, 1985); Health Belief Model (Becker, 1974; Rostenstock 1966); Health Locus of Control (Rotter et al., 1972); Stages of change model / Transtheoretical Model (Prochaska & Velicer, 1997; DiClemente & Prochaska, 1998; Prochaska & DiClemente, 1983) and COM-B model (Michie et al, 2011). A few of the theories will briefly be discussed below, followed by the main model used within this research piece (COM-B model) discussed in greater detail.

The Theory of Planned Behaviour (TPB) model (Ajzen, 1991; 1985), places intention at the centre of the model (Figure 2.1), whereby individuals have thoughtfully considered the behaviour change needed and subsequently made an intention to change said behaviour. Intention, within this model, is driven by three factors, namely: attitude; subjective norm and perceived behavioural control with actual behavioural control having an influence on perceived behavioural control and behaviour itself. The Theory of Planned Behaviour has made wide application to a number of different health behaviours, including smoking cessation and physical

activity (Ajzen, 2011; Hardeman et al., 2001; Poverty et al., 2000), and has been shown to account for 27% of variance in behaviour (Armitage & Conner, 2010). However, criticisms of the model are noted which include the exclusion of unconscious influences or the role of emotions upon behaviour (Sniehotta, Presseau & Araújo-Soares, 2014; Sheeran, Gollwitzer & Bargh, 2013; Conner et al., 2013).

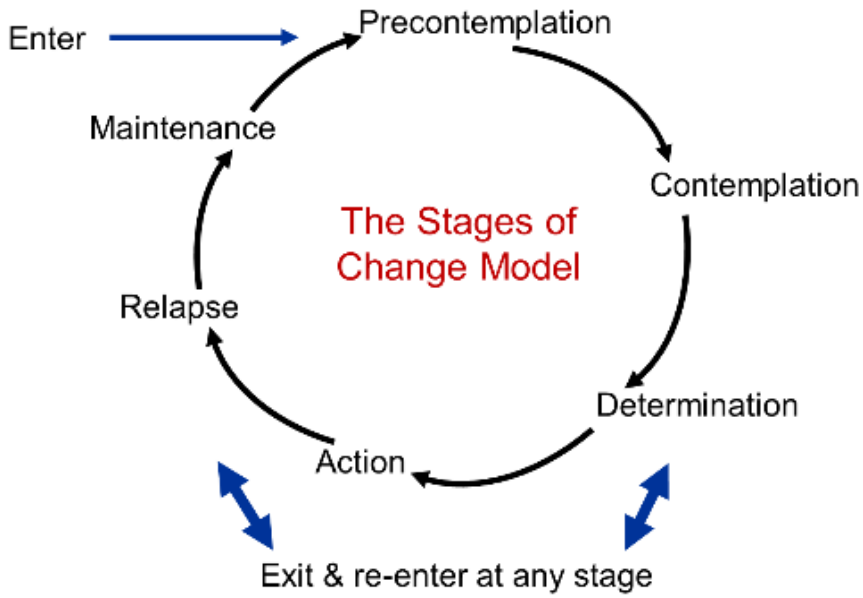
Figure 2.1 The Theory of Planned Behaviour (Ajzen, 1991)



In contrast, the Transtheoretical Model or Stages of Change model (Figure 2.2) describes behaviour as a dynamic process consisting of six distinct stages (Prochaska & DiClemente, 1983). These include: Precontemplation (the individual does not intend to change behaviour in the foreseeable future (next six months)); Contemplation (the individual considered the pros and cons to making a change in behaviour and intends to change in the next six months); Preparation (the individual intends to change behaviour in the next month); Action (the individual has made modifications to their behaviour in the past six months); Maintenance (individuals have made successful behavioural change and are now working to prevent relapse); Relapse (individuals may relapse at any point within the model). This model was

primarily constructed to explain stages of smoking behavioural cessation, but has since been adapted to other health behaviours (Bridle et al., 2007;Spencer et al., 2006; Marhsall & Biddle, 2001; Prochaska & Velicer, 1997; Prochaska et al., 1994). Criticism of the model include the fact that different stages of the model are defined by arbitrary lines which perhaps fails to translate into real world settings and the model is primarily based on an individual's ability to form and keep to set plans (West, 2005; Littel & Girvin, 2002; Sutton, 2001; Bunton et al., 2000; Etter & Perneger, 1999).

Figure 2.2 The Stages of Change Model (Prochaska & DiClemente, 1983)

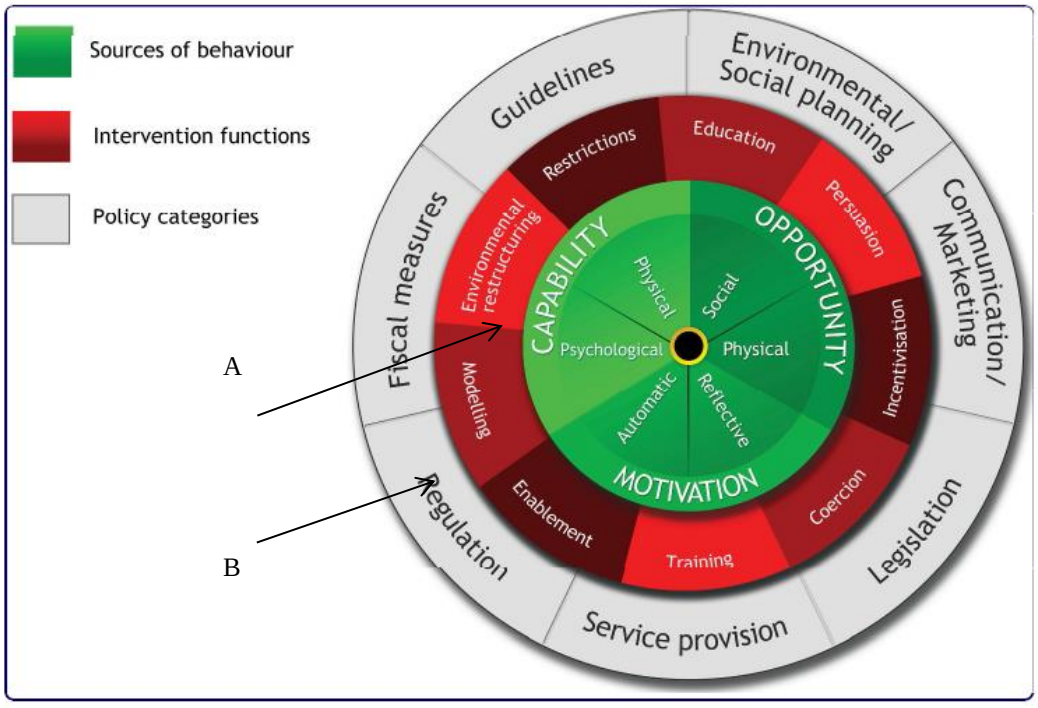


Source: LaMorte, W.W. (2018). The Transtheoretical Model (Stages of Change). Boston University School of Public Health.

2.2.1 COM-B Model and Theoretical Domains Framework (TDF)

One of the most widely accepted behavioural change models currently used is the COM-B model (Figure 2.3) (Michie et al., 2011). At the centre of this framework, which is constructed as a wheel, is the 'behaviour system' which comprises of the three key conditions to facilitate behaviour change. These include Capability, Opportunity and Motivation.

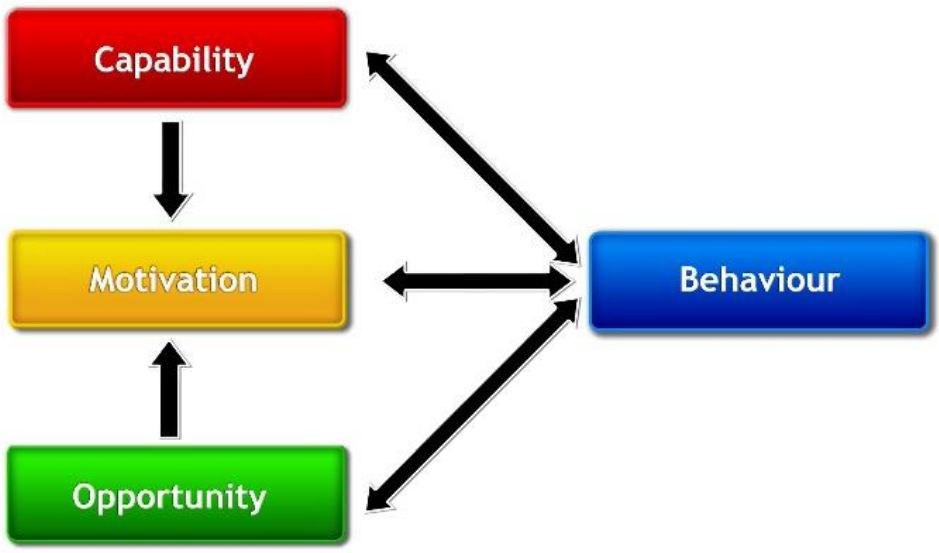
Figure 2.3 COM-B Model of behaviour change (Michie et al., 2011)



The authors define Capability as an "individuals psychological and physical capacity to engage in the activity concerned. It concludes that it is necessary for people to have a level of knowledge and skills" (Michie et al., 2011, pg 4)'. For example, within the dental context, this component may ensure that, through education, individuals have sufficient knowledge around how often it is advised to perform tooth brushing and the positive impact brushing their teeth would have on their oral

health. In addition, it might also include ensuring that individuals have appropriate skill in how to use dental floss. Opportunity is defined as "all the factors that lie outside the individual that make the behaviour possible or prompt it" (Michie et al., 2011, pg 4). For example, within the dental context, this might include ensuring availability of dental check-up appointments for individuals to make preventive visits. Finally, Motivation is defined as "all those brain processes that energize and direct behaviour, not just goals and conscious decision-making. It includes habitual processes, emotional responding as well as analytical decision making" (Michie et al., 2011, pg 4). Figure 2.4 shows how the three key conditions interact with each other to influence individual behaviour.

Figure 2.4 Interactions of the three key conditions of the COM-B model (Michie et al., 2011)



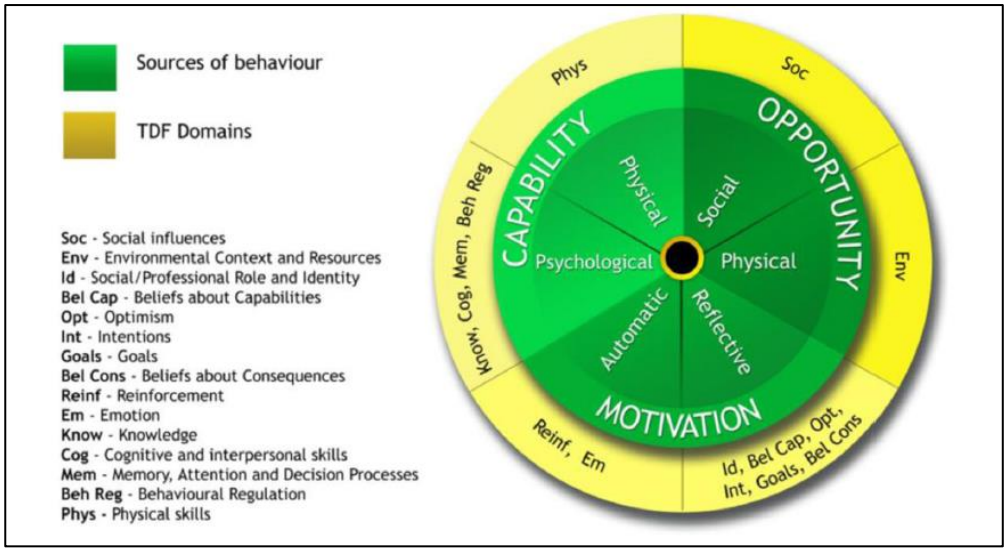
In addition to the three key conditions, the COM-B model has an outer two layers of the wheel with nine different intervention functions (labelled 'A' in Figure 2.3) and

seven categories of policy (labelled ‘B’ in Figure 2.3) which are identified as able to facilitate interventions. The intervention functions help frame how the intervention might improve deficiencies in one or more of the conditions (capability, opportunity and motivation). For example, one of the intervention functions is ‘Enablement’. Within the dental context, this might include provision of dental supplies to encourage tooth brushing behaviour (Cibulka et al., 2011; Binkley, 2007). Indeed, Public Health England (2017) has estimated that the postal delivery of tooth brushes and toothpastes to children will result, after 5 years, in “1,025 school days gained per 5,000 children”. In the outermost layer of the wheel (labelled ‘B’ in Figure 2.3) identifies seven categories of policy which may be able to facilitate the intervention. For example, one policy category is ‘Guidelines’ and within the dental context, an example would be the development of Delivering Better Oral Health (DBOH) by Public Health England (2014), which gives guidance to primary dental care teams on prevention of oral diseases. The COM-B model, therefore, is a useful framework within which interventions can be designed in order to yield positive behaviour change outcomes.

In addition to COM-B model, the Theoretical Domains Framework (TDF) is a synthesis of 128 theoretical constructs from 33 theories of behaviour and behaviour change grouped together into 14 domains (the majority of which relate to factors around an individual’s motivation and capabilities). It provides a validated theoretical framework in which to explore the social, environmental, cognitive and affective influences upon behaviour (Atkins et al., 2017; Cane, O’Connor & Michie, 2012; Michie et al., 2005), and has been used extensively both within and outside the healthcare setting. The 14 domains include beliefs about consequences; social /

professional role and identity; knowledge; skills; beliefs about capabilities; motivation and goals; memory, attention and decision processes; environmental context and resources; social influences; emotion; behavioural regulation; nature of the behaviours. The domains from the TDF can be mapped onto the inner wheel of the COM-B model components (Figure 2.5).

Figure 2.5 Mapping of TDF onto the COM-B model (Atkins et al., 2017)



The application of the TDF has enjoyed success in studies relating to the identification of behavioural influences. For example, Patey et al. (2012) used the TDF as a theoretical framework in which to understand the factors which influence an anaesthesiologist/surgeons decision in ordering pre-operative tests prior to surgery in low-risk patients. The application of the TDF has also been applied to the systematic design of interventions. For example, the TDF was used with success in the implementation of national guidelines around the placement of nasogastric tubes. Indeed, a statistically significant increase in uptake of guidelines was experienced across intervention hospital using the TDF approach compared to control, which was reported to have an annual saving of £2.56 million (Taylor et al., 2014).

The thesis supports the recognition of the COM-B model used alongside habit formation theoretical approaches. The habit formation approach builds on traditional models of behaviour change (synthesised into the 'COM-B' (capability, opportunity, motivation, behaviour) framework (Michie et al, 2011), but adds the concept of 'context-dependent repetition', which develops habit associations (Lally et al., 2010). Whilst a number of different behavioural change approaches are recognised, such as the Health Action Process Approach (HAPA), the utilisation of COM-B model alongside habit formation theory was deemed advantageous as the establishment of habitual behaviour is advantageous for a number of reasons including: 1) behaviour is performed via automatic processing (Gardner 2012; Lally et al., 2010; Wood & Neal, 2009; Verplanken & Wood, 2006); 2) behaviour continues to be performed even when motivation and intention wane (Neal et al, 2011; Lally, Gardner & Wardle, 2011; Gardner et al., 2011; Wood & Neal, 2009; Hall & Fong, 2007; Weinstein, 2007; Verplanken & Wood, 2006; Triandis, 1977); and 3) habitual behaviour has been shown to result in behaviour maintenance in the longer term (Kwasnicka et al., 2016; Rothman, Sheeran & Wood, 2009; Rothman, 2000).

2.2.2 Behavioural change approaches

In terms of behavioural change, a number of different approaches can be used. These include: individual; community or family; or population level (NICE, 2014; NICE, 2007; Watt, 2007). However, it is noted, that although an intervention or behavioural change programme may primarily be delivered at one of these three levels, the effects of such are rarely restricted to the level at which it is delivered (NICE, 2007). An example of how each approach has been applied to the dental context is discussed below.

1. Individual level: Cibulka et al. (2011), recruited 170 pregnant American woman from a low income area, delivered a 5 minute DVD presentation on periodontal disease, demonstrating techniques for efficient tooth brushing and flossing alongside giving dental supplies, scheduling dental appointment and also sending a reminder postcard to attend the scheduled appointment. This complex intervention resulted in a significant increase in dental attendance.

2. Community or family level: Clarke (2007) recruited thirteen Community Health Advisors (CHA) to disseminate oral health education within their community in a variety of ways including discussion with friends and family around the importance of oral health. This intervention was compared to a similar town in America with similar participant characteristics. This resulted in a greater attendance for regular dental visits.

3. Population level: perhaps the most notable in the dental context, is centred on water fluoridation. Although controversial, water fluoridation has repeatedly been shown to reduce the incidence of dental caries (Iheozer-Ejiofor et al., 2015; McDonagh et al., 2000; Brunelle & Carolos, 1990).

2.3 Behavioural maintenance

For behaviour change interventions to be truly effective behavioural change needs to be maintained so that oral health or health in general benefits throughout the life course. Indeed, literature repeatedly demonstrated the interventional effect diminish over time (normally following cessation of intervention) (Dombrowski et al., 2014; Fjeldsoe et al., 2011; Dombrowski, Avenell & Sniehotta, 2010; Tobias, 2009; Curioni & Lourenco, 2005). Therefore it is important to understand theory relevant to maintenance when developing interventions.

A recent systematic review of theoretical explanations for behaviour change maintenance, reported five main themes relevant to maintenance (Kwasnicka et al., 2016). These included: maintenance motives (Rothman, 2000; Rothman et al., 2009; Higgins, 2006; Deci & Ryan, 1985); self-regulation (Kanfer & Gaelick, 1991; Marlatt & George 1984; Hofmann et al., 2008); resources (Strack & Deutsch, 2004; Baumeister, 2002; Muraven & Baumeister, 2000; Stroebe et al., 2008); habit (Hunt & Martin, 1988; Verplanken & Aarts, 1999; Verplanken & Orbell, 2003; Verplanken et al., 2008; Greaves, Reddy & Sheppard, 2010) and environmental and social influences (Bandura, 1986; Thompson & Kinne, 1990; May & Finch, 2009). The five themes help in both the development and evaluation of interventions which aim to establish healthy behavioural changes (Kwasnicka et al., 2016).

2.4 Oral Health

One definition of oral health comes from the World Health Organisation (WHO) which defines it as "a state of being free from chronic mouth and facial pain, oral and throat cancer, oral infection and sores, periodontal (gum) disease, tooth decay, tooth loss, and other diseases and disorders that limit an individual's capacity in biting, chewing, smiling, speaking and psychosocial wellbeing" (World Health Organization, 2018). Another definition from the American Dental Association defines oral health as "a functional, structural, aesthetic, physiologic and psychological state of well-being and essential to an individual's general health and quality of life" (ADA, 2014), giving the complex picture of how both physiological and psychological factors impact upon oral health.

2.4.1 Oral diseases and disorders

The main oral diseases and disorders which affect an individual are dental caries and periodontal disease. Whilst others are recognised, such as bacterial, fungal and viral disease of the mucosa, malignant and premalignant conditions such as mucosal dysplasia and oral submucous fibrosis (OSMF), and temporomandibular joint (TMJ) disorders, the thesis and literature review will focus on the two main diseases which will be discussed in turn to detail their worldwide and individual level health impact.

2.4.1.1 Dental caries

Dental caries is the result of demineralisation of the enamel and dentine structure (Kidd & Fejerskov, 2016; Pitts & Zero, 2016; Takahashi & Nyvad, 2011). Dental plaque, which contains a variety of different oral bacteria, accumulates as a biofilm on teeth (Marsh & Zaura, 2017; Rosan & Lamont, 2000; Loesche, 1986). Organic acids (such as lactic acid) are produced from the anaerobic metabolism of fermentable, dietary sugars by bacteria (predominantly Streptococcus Mutans) within the dental plaque (Guo et al., 2013; Matsui & Cvitkovitch, 2010; Banas, 2004; Hamada & Slade, 1980; Dashper & Reynolds, 1996; 1980), resulting in demineralisation of the teeth and the development of dental caries. As a result, individuals are susceptible to dental caries throughout the life course (Broadbent et al., 2013; Griffin et al., 2005, Thomson 2004).

According to the Global Burden of Disease study (2015), untreated dental caries in the permanent dentition affected 2.5 billion people worldwide. It was the most prevalent condition within this dataset, with only a small (0.2%) decrease since 1990 (Kassebaum et al., 2017). In addition, data from the United Kingdom shows that the

most common cause for admission to hospital for children for a General Anaesthetic (GA) is dental caries (Knapp, Marshman & Rodd, 2017; Steele et al., 2015), which carries with it, its own risks of mortality and morbidity. These figures help paint the picture of the severity of the burden of dental caries worldwide.

2.4.1.2 Periodontal disease

Periodontal disease is caused by bacteria within dental plaque releasing toxins to the surrounding gingiva (gums), which stimulates a chronic inflammatory response in the body, resulting in swollen and infected gingiva. At this stage, the disease is called gingivitis. However, mild gingivitis can subsequently progress to more severe forms of periodontal disease, periodontitis, as the chronic inflammatory response eventually leads to the resorption of the supporting bone around teeth causing them to become loose, possibly even requiring extraction (removal) (Lang & Bartold, 2018; Hajishengallis, 2015; Broadbent et al. 2011).

Again, within the Global Burden survey, the incidence of severe periodontitis worldwide in 2015 was 538 million, up from 307 million in 1990 (Kassebaum et al., 2017). This increase in incidence may be explained in part by the growing aging population or by the global increase in tooth retention (Tonetti et al., 2017; Jepsen et al., 2017; Stock et al., 2016). Within the 2009 Adult Dental Health Survey (ADHS) in the United Kingdom, only 17% of dentate adults had adequate gingival health on clinical examination (no bleeding, no calculus and no periodontal pocketing of 4mm or more) (NHS Digital, 2013). In addition, 66% of dentate adults had visible plaque on at least one tooth, with the average number being six.

2.4.2 The effects of poor oral health

Having poor oral health impacts people's lives in a number of ways. For example, it affects an individual's ability to speak and / or chew and can alter the taste perception of food, resulting in food avoidance (Ástvaldsdóttir et al., 2018; White et al., 2012; Savoca et al., 2010; Chalmers et al., 2002; Locker & Grushka, 1987). For example, a recent qualitative study exploring the impact of dental caries on children aged 5-15 years old, reported having to adopt new strategies due to dental pain, including avoiding food or changing to a 'softer diet' (such as soup) (Gilchrist et al., 2015). Similar findings were reported in a cross-sectional survey in Thailand with 707 older Thais, where 47.2% of participants reported negative impact of eating due to oral conditions (Srisilapanan & Sheiham, 2008). In addition to this, poor oral health can lead to disturbance of sleep with as many as 27% of adults' nationally experiencing dental pain (Pau, Croucher & Marcenes., 2007).

Finally, poor oral health has a negative economic and societal impact. Economic impact may be classified as direct (i.e. treatment cost) or indirect (i.e. absenteeism from work, due to dental pain and/or attendance of emergency dental appointments, results in a reduction of productivity) (Listl et al., 2015; Jin et al., 2015; Gift & Atchison, 1995). According to the global burden of disease study, the direct cost of dental disease was US$298 billion (US$133 billion for indirect). This accounted for 4.6% of the global expenditure on health (Listl et al., 2015). It is estimated that globally, millions of school and work hours are lost each year related to oral diseases (Jackson et al., 2010; Petersen, 2003). For example, a cross-sectional study conducted in Canada, reported over 40 million hours of work is lost each year in Canada due to dental disease (Hayes et al., 2013). This is also mirrored in the school

context for children. For example, Guarnizo-Herreño & Wehby (2012) showed that dental problems were significantly associated with poorer performance as well as absenteeism from school in a representative sample of children from the United States. Therefore, there is a pressing need to maintain good oral health.

2.5 Oral health behaviours

There are a number of different individual behaviours which contribute to the establishment of good oral health by eliminating and preventing disease. This means that poor oral health is almost entirely preventable. Behaviours include: regular tooth brushing with fluoridated toothpaste; interdental cleaning (e.g. flossing, using interdental brushes); mouth rinsing; xylitol consumption; attending dental check-ups; controlled consumption of dietary sugars consumed as part of a balanced diet; cessation or smoking and/or chewing of pan and controlled intake of alcohol consumption. The following sections will discuss each behaviour briefly (to give an overview).

2.5.1 Tooth brushing

Regular tooth brushing, with a fluoridated toothpaste (at concentrations of 1,000ppm or above), has been repeatedly demonstrated to reduce dental caries (dos Santos, Ndanovsky & de Oliveira, 2013; Frencken et al., 2012; Buzzalaf et al., 2011; Wong et al., 2011) and help maintain good periodontal health (Zimmermann et al., 2014; Saxlin et al., 2011; Al Habashneh et al., 2010; Han et al., 2009). This simple behaviour simultaneously delivers two important benefits. First, it removes harmful dental plaque from the mouth. If not removed regularly, the bacteria within the dental plaque releases toxins to the surrounding gingiva, stimulating a chronic inflammatory

response in the body. This results in swollen and infected gums and will eventually lead to resorption of the supporting bone around teeth causing them to become loose (Lang & Bartold, 2018; Hajishengallis, 2015; Broadbent et al. 2011). Secondly, fluoride from the toothpaste is delivered to the mouth which helps to resist demineralisation of teeth following the consumption of sugar. It is most effective in preventing decay when delivered regularly to the tooth surface (Pitts et al., 2017; Walsh et al., 2010). Bed-time brushing is particularly important because saliva flow is reduced at night, tipping the balance in favour of tooth decay (Thie et al., 2002). Therefore, twice-daily tooth brushing (particularly at bed-time) is important in maintaining oral health.

2.5.2 Interdental cleaning

Interdental cleaning includes flossing, using interdental brushes, interdens toothpick or woodstick. In addition to tooth brushing, flossing once daily (recommended within a national prevention toolkit in the United Kingdom (Public Health England, 2014)) has been shown to improve periodontal health by reducing plaque (Sambunjak et al., 2011; Hague, 2007; Schiff 2006; Jared et al., 2005). The same has been demonstrated for interdental brushing (Poklepovic et al., 2013; Imai et al., 2011; Ishak et al., 2007) with perhaps some suggestion from a recent meta-analysis that interdental brushes are superior to flossing for the removal of dental plaque (Sälzer et al., 2015). Flossing and interdental brushing effects on prevention of dental caries is still a debatable area and therefore requires further long-term research. For example, a recent Cochrane review concluded a lack of evidence of the effectiveness of flossing and brushing compared to tooth brushing alone (Sambunjak et al., 2011).

2.5.3 Mouth rinsing and xylitol consumption

Mouth rinsing with fluoride and/or chlorhexidine may be beneficial for good oral health. Fluoride mouth washes have been repeatedly shown to have a beneficial effect on preventing dental caries (Twetman & Keller, 2016; Marinho et al., 2016) and chlorhexidine mouth washes are beneficial against plaque growth (Supranoto et al., 2014).

Xylitol consumption has been proposed to reduce the incidence of dental caries by reducing the levels of Streptococci Mutans within dental plaque. It is most commonly used as a sugar substitute and is available in a number of forms including toothpaste and chewing gums. A recent systematic review is in keeping with other evidence around the lack of evidence on the effectiveness of xylitol-containing products to reduce dental caries (Riley et al., 2015; Janakiram, Kumar & Joseph, 2017), although some studies have demonstrated a positive effect on caries reduction (Nayak, Nayak & Khandelwal, 2014). Therefore, further work is required to establish the role xylitol plays within establishing good oral health.

2.5.4 Dental check-ups

Regularly visiting the dentist also contributes to good oral health as it reduces the levels of both dental caries and tooth loss long term (Broadbent et al., 2016; Åstrøm et al., 2014; Palència et al., 2013; Crocombe et al., 2011; Watts & Meenan, 2002). For example, a study conducted in New Zealand followed 932 participants over a 17 year span (from age 15 to 32) and demonstrated that individuals who regularly attended for dental check-ups had not only better self-reported oral health, but also clinically, less tooth loss and dental caries (Thompson et al., 2010). Dental

attendance is also associated with a positive impact upon an individuals reported quality of life (QoL) (Almoznino et al., 2015; Montero, Albaladejo & Zalba, 2014; McGrath & Bedi, 2001). Thus regular dental examinations at a dental practice are recommended: in the United Kingdom, regular dental examinations are part of national NHS guidance (NICE, 2004).

2.5.5 Cessation of smoking and controlled intake of alcohol

In addition to the well-established link of cigarette smoke and lung pathology (Torre, Siegel & Jemal, 2016; Islami, Toore & Jemal, 2015; Hecht, 2002), there is also a well-established link between cigarette smoking and oral cancer (Kumar et al., 2016; Rivera, 2015; Blot et al., 1988). In addition, cigarette smoking also has a negative impact upon gingival and periodontal health (Lee, Taneja & Vassallo, 2012). Cessation of smoking reduces these risks significantly. In addition, alcohol consumption has been demonstrated to be a risk factor to oral cancer and when combined with smoking; this has a significant synergic effect (Rivera, 2015).

2.5.6 Controlled consumption of dietary sugars

Finally, consumptions of dietary sugars have also been shown to deleteriously affect oral health. A recent systematic review to inform WHO guidelines, demonstrated an increase in ingestion of free sugars significantly increases dental caries experience (Moynihan & Kelly, 2014). This has been mirrored in numerous other studies (Moynihan et al., 2018; Bernabe et al., 2016; Sheiham & James, 2015). Globally, there is a need to ensure individuals reduce their intake of free sugars for both oral and general health (e.g. reduction in obesity) (Khan & Sievenpiper, 2016; Hu, 2013; Mann, 2004).

2.6 Oral Health inequalities

In addition, there is also a social gradient to oral health; with people within low socio-economic status (SES) having higher levels of disease compared to individuals from higher SES groups (Watt et al., 2016; Gupta et al., 2015; Heilmann et al., 2015; Steele et al., 2014; Sheiham et al., 2011; Sabbah et al., 2007). For example, a recent cross-sectional survey of 2216 primary school children from a mixture of both high and low SES areas in Belgium demonstrated higher levels of dental caries and plaque in children living within low SES regions (Lambert et al., 2017). This is also evident within the adult population. A recent study on Finnish adults showed higher levels of dental caries among those individuals with basic levels of education (Sabbath et al., 2015). In terms of regular dental attendance, many people with low socio-economic status have an 'emergency' pattern of visiting behaviour - seeking dental care only when prompted by symptoms. This is associated with a larger number of extracted teeth and greater levels of untreated oral disease (Donaldson et al., 2008). The most recent UK Adult Dental Health Survey reported 55% of routine and manual occupations compared with 66% of managerial and professional occupations attend dental services regularly (NHS Digital, 2013). A social gradient in dental visiting behaviour has been attributed, at least in part, to oral health inequalities (Sanders et al., 2006) and is mirrored in tooth brushing & interdental cleaning behaviour (Arrica et al., 2017).

2.7 Previous interventions to establish good oral health

The mainstay of behavioural change within the dental context remains within one-to-one interventions, predominantly delivered within the dental context.

In recent years, there has been a move away from traditional education only oral hygiene (tooth brushing and interdental cleaning) interventions for behavioural change. This is due to the lack of effectiveness and long term sustained change in behaviour (Gao et al., 2014; Kay & Locker, 1998). At the same time, there has been an increase in interest in the effectiveness of psychological interventions for oral hygiene instructions with positive results (Newton & Asimakopoulou, 2015; Gao et al., 2014; Brand et al., 2013; Stenman et al., 2012; Suresh et al., 2012; Godard et al., 2011; Renz et al., 2007). For example, a recent systematic review, explored the effectiveness of motivational interviewing (MI) to improve oral health compared to conventional (health) education (CE) (Gao et al., 2014). The review demonstrated that MI interventions are effective in improving periodontal health through oral hygiene measures in five of the seven included trials, concluding that this type of intervention may be beneficial.

Specifically, in terms of tooth brushing interventions, interventional approaches appear to predominantly focus around children. For example, multiple tooth brushing interventions have used the school setting to deliver tooth brushing programs to children (Borges-Yáñez et al., 2017; Wolff et al., 2016; Petersen et al., 2015; Amalia et al., 2011; Al-Jundi, Hammad & Alwaeli, 2006). It is considered that the establishment of tooth brushing behaviour in childhood will result in long term behavioural maintenance throughout the life course. As an example, in the United States, a nine year study assessed the effectiveness of a tooth brushing program delivered within the school setting in low socio-economic area (Ruff & Niederman, 2018). The results demonstrated a reduction in overall caries experience and lower overall mean DMFT (decayed, missing, filled teeth) in the schools which received

the tooth brushing program compared to those schools which did not. As in other examples, implemented in a number of different global locations, this have been demonstrated to be successful at improving oral health (Borges-Yáñez et al., 2017; Wolff et al., 2016; Petersen et al., 2015; Amalia et al., 2011; Al-Jundi, Hammad & Alwaeli, 2006). However, the translation of the longer term establishment of behaviour from childhood into adult hood is debatable and requires further exploration (Aunger, 2007; Wind et al., 2005).

Therefore, having explored the magnitude of the global burden of oral disease, and established oral health behaviours which can predominantly prevent their occurrence, the rest of the chapter will discuss a novel approach to the dental setting which may be effective at establishing and maintaining desirable oral health behaviours.

2.8 Habits

The concept of habit goes back to 1891 (James, 1891), where the idea of automatic behaviour developing from the constant repetition is recorded. According to the dual processing model (a theoretical model used to explain behaviour conduct), behaviour is considered to occur through two different processes or systems: System 1 and System 2 (Evans & Stanovich, 2013). System 1 is considered to be impulsive, automatic and adaptive unconscious in comparison to System 2 which is reflective, controlled and conscious, requiring psychological resources to perform (Hofmann, Friese & Wiers, 2008; Strack & Deutsch, 2004; Evans, 2003).

2.8.1 Defining habits

Within the psychology literature, there are a number of different accepted definitions of habit based on how the concept helps predict, explain and account for change in behaviour. For example, a recent review by Gardner (2015) into defining the habit concept identified eight literature reviews which all describe 'elements of a process whereby behaviour is contextually cued, without conscious thought, via activation of a mental context-consistent performances' (page 278) in their habit definitions. However, three differing concepts emerged related to where the habit was positioned within this process. Five of the eight included reviews defined habit as 'behaviour generated by this process' (Gardner et al., 2011, 2012; Nilsen, Bourne & Verplanken, 2008; Nilsen, Roback, Broström, & Ellström, 2012; van t'Riet et al., 2011), two reviews defined habit as the 'automaticity of responses' (Verplanken & Wood, 2006; Wood & Neal, 2009), whilst the last review termed habit as a 'tendency to engage in behaviour' (Ouellette & Wood, 1998). The author concludes the work by proposing a new definition for habit which goes some way to addressing the criticisms and flaws of these eight definitions: "habit is a process by which a stimulus generates an impulse to act as a result of a learned stimulus-response association" (page 280). This highlights the fact that habits are defined in terms of being a cognitive mechanism, rather than behaviour itself, as previously proposed. Therefore, with this definition in mind, habits can be thought to be positioned within system 1 of the dual processing model. A stimulus (cue) is required to initiate behaviour and the process occurs automatically (discussed later).

Establishing healthy habits is beneficial for a number of reasons. As they are considered to be performed using an automatic nature without cognitive effort, they

allow planning resources to be utilised on other behaviours. In addition, when established, habitual behaviour is still conducted even when motivation to perform the behaviour has waned (Neal et al, 2011; Lally, Gardner & Wardle, 2011; Weinstein, 2007). Habits are also a good predictor for future behaviours (Gardner, de Bruijn & Lally, 2011; Adriaanse, de Ridder & Evers, 2011; Allom & Mullan, 2012; Lawler et al., 2012) and they will continue to be performed even when they conflict with deliberate intentions (Gardner et al., 2011; Wood & Neal, 2009; Hall & Fong, 2007; Verplanken & Wood, 2006; Triandis, 1977).

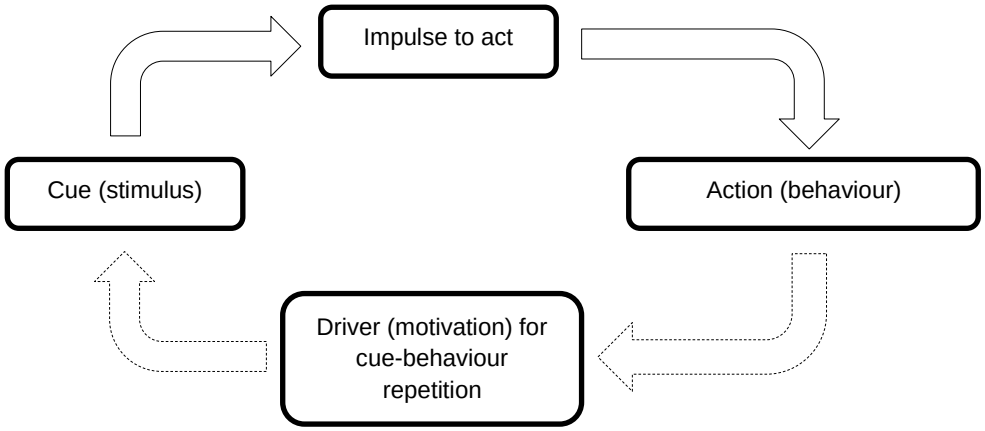
Habitual behaviour can be subdivided into behaviour instigation and behaviour execution – to take account of a discrete difference between "deciding" (behavioural instigation or intention) and "doing" (behaviour execution or action) the particular behaviour (Gardner, Phillips & Judah, 2016). As either, both or none of these subcomponents (behaviour instigation or execution) can be automatically primed, it is important to distinguish which, if any, of the oral health behaviours subcomponents are conducted in a habitual (automatic) manner, since emerging research suggests that habit instigation may be more important than habitual behaviour execution, for long term maintenance of frequent behaviours (Phillips & Lally, 2016).

2.8.2 Habit formation

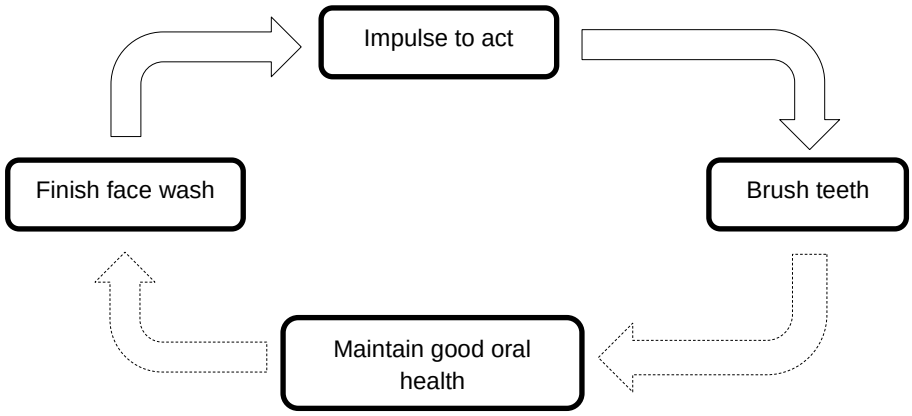
It has been proposed that to form a habit, two important stages are required (Lally & Gardner, 2013; Gardner, Lally & Wardle, 2012). This section will go through each stage and discuss it fully. Figure 2.6 conceptualises how habitual behaviour forms and gives an example in relation to tooth brushing behaviour.

Figure 2.6 How habits form (a) and a possible example for tooth brushing behaviour (b)

(a)



(b)



1. <u>Initiating a new behaviour</u>

Intention

To make a new behaviour habitual, individuals first need to have an intention to perform the behaviour (Fife-Schaw, Sheeran & Norman, 2007; Armitage & Conner, 2001). A meta-analysis by Webb & Sheeran (2006) of 47 empirical studies showed that a medium to large change in intention translates to a small-to-medium change in

behaviour. In addition, the salience, strength and stability of an intention influence whether an individual will perform a future behaviour if the opportunity arises (Sheeran, Orbell & Trafimow, 1999).

Intention-behaviour gap

As Webb & Sheeran's meta-analysis indicates, having the intention to perform behaviour often is not sufficient to translate this into behavioural action. For example a meta-analysis of the 'gap' between intention and behaviour, showed that 53% of participants failed to translate intention into behaviour (Sheeran, 2002). This phenomena is known as the 'intention-behaviour gap'. Therefore, mechanisms within behavioural change interventions are required to help resolve this gap. One way is by planning to perform the behaviour (Sniehotta et al., 2005). A useful mechanism of action planning which has been used by researchers is 'Implementation Intentions' (II). Forming IIs (Golliwitzer 1999) involves specifying when, where and how a behaviour will be completed by completing an 'if-then plan'. These 'if-then' plans require individuals to decide 'If I encounter X cue (particular situation/thing), I will do Y behaviour'. They are important in heightening individual's awareness of the predetermined cue and in establishing a mental link or trace between the specific cue and the appropriate action (Webb & Sheeran, 2007; Gollwitzer & Sheeran, 2006; Webb & Sheeran, 2008). In addition, control for the performance of the behaviour is transferred from the self to the environment (cue). II's have been shown to have a small to medium effect size on the taking of physical exercise (Belanger-Gravel, 2013) and a strong effect on eating a healthy diet (Adriaanse, Vinkers, De Ridder, Hox & De Wit, 2011).

Cues

In relation to cues, these may be considered to fall into three categories, namely: time based, event based and activity based, all reliant upon prospective memory (PM). Time based cues initiate behaviour at a certain time of the day; event-based cues initiate behaviour by something in the environment, such as an object; whilst activity-based cues initiate behaviour at the end of a predetermined activity (Einstein & McDaniel, 1990; Kvavilashvili et al., 1996; Harris, 1984). Time-based cues are often discouraged in establishing desired behaviour due to the need for cognitive thought around the time of day to act (Stawarz, Cox & Blandford, 2014). Specifically, a cue can be described as a salient feature, present consistently within an individual's environment; easily identified and occurring in a repetitive manner and set within the context of a routinised behavioural sequence. Some examples may include a specific time of day; after dinner or an event; seeing an object in a certain place; or on arrival at work.

2. Supporting context-dependent repetition and facilitating the development of automaticity

Rothman (2000) reported that 'decisions regarding behavioural initiation are predicted to depend on favourable expectations regarding future outcomes, whereas decisions regarding behavioural maintenance are predicted to depend on perceived satisfaction with received outcomes' (page 64). Therefore, in order to establish behaviour as habitual, an individual must repeat it consistently and so be satisfied with the outcome of behaviour performance.

Context-dependent repetitions

Context-dependent repetitions are important for habit formation. A new behaviour should be prompted by encountering a specific cue within a stable context (Wood, Quinn & Kashby, 2002; Ouellette & Wood, 1998). This constant initiation of behaviour to a specific cue in a stable context leads to habit formation (McGowan et al., 2013; Lally et al., 2010). In addition, it is expected that when the stable context changes and the salient cue is no longer encountered, one of two things result. Either the automatic behaviour will be dormant, but activated when the cue is re-encountered (implicit habit) or the association and automaticity will be lost over time (habit decay) (Tobias, 2009).

Rewards

Rewards may help encourage behaviour repetition and can be classified into two categories: extrinsic (e.g. financial incentives such as money or vouchers) and intrinsic (e.g. intrinsic motivation). The use of financial incentives for smoking cessation in pregnant women has been demonstrated to be very effective (Tappin et al., 2015). Indeed, a recent meta-analysis demonstrated the positive effect of financial incentives for encouraging healthy behaviour change (Giles et al., 2014). However, care should be taken when considering the use of extrinsic rewards as they can drive behaviour in a goal-directed manner, rather than to be conducted habitually. In addition, behaviour may cease when the reward for performance is removed (Wood & Neal, 2009). Intrinsic rewards may perhaps be more self-sustaining and evidence has shown the positive effect on habitual formation of intrinsic motivation (Weidemann et al., 2014; Gardner & Lally, 2013).

Automaticity

Automaticity is considered to be a continuum, consisting of four features; absence of deliberation, absence of awareness, absence of mental effort and absence of conscious control (Bargh et al, 1994; Bargh, 1992). It has been argued to be the defining feature of habit behaviour (Gardner, 2012). A study exploring habit formation process in the real world (Lally et al., 2010), showed an asymptotic curve for behavioural automaticity, indicating gains in automaticity occurs quickly at the start of behaviour repetition. It also suggested that automaticity can take different times to be established in different individuals; 18-254 days to reach limit of automaticity with a median time of 66 days.

2.8.3 Measurements of habit

Two main measures of habitual health behaviours have been used. These include:

1. Behaviour Frequency x Context Stability (BFCS)

This measure uses the concept that past behaviour cued by a particular location, time or person, can accurately measure future behaviour when behaviour continues to be performed in a stable context (Ouellette & Wood (1998). It asks the questions, 'How often do you do behaviour X'? (behaviour frequency), and 'When you perform behaviour X, how stable are the circumstances? (context stability)'.

For example, Danner et al (2008) used the BFCS measurement in predicting behaviour for a number of behaviours (snacking, alcohol & milk consumption & active travel). They asked participants to self-report how often they completed each task and the stability of the context on a 9-point Likert Scale. These two values were then multiplied together to give a numerical value which could be applied to the

habit strength scale. Higher values within a given habit strength scale indicate a strong habit. Although this measure has also been utilised in studies to measure snacking / drinking behaviour (Adriaanse et al., 2010), purchasing fast food (Ji & Wood, 2007) and physical activity (Neal et al., 2013), the main limitation is the lack of incorporation of the main active ingredient of habitual behaviour, automaticity. Indeed, some behaviour can be performed repeatedly within stable context but still require cognitive, thoughtful processing (Ajzen, 2002). In addition, identification of the cue (X) to initiate behaviour (Y) should be individualised to each participant.

2. Self-reported Habit Index (SRHI)

This is the most commonly used index for habit measurement and consists of twelve items (measured on a Likert Scale) which measure three different features of habit, namely behaviour frequency, automaticity and self-identity (Verplanken & Orbell, 2003). The index may also be adapted to include contextual cues and behaviour initiation or execution by adjustment to the question stem (Sniehotta & Presseau, 2012). Whilst this measure enjoys widespread use, it has been argued that some items within it may be unnecessary, namely self-identity and behaviour frequency. Self-identity is not usually associated with the definition of habit and behaviour frequencies, whilst potentially helping to establish habitual behaviour through repetition, are dependent on encountering a cue to initiate behaviour. Therefore, a subscale of the SRHI, the 'Self-Report Behavioural Automaticity Index (SRBAI)' has been developed (Gardner et al., 2012). This scale consists of four items (measured on a Likert Scale) and measures the automaticity of behaviour. It has been found to be a reliable, sensitive and efficient scale to measure automaticity (Gardner

et al., 2012) and also reduces participant burden when completing self-reported questionnaires.

Two other measures of habitual behaviour have been used but not commonly. These include:

1. Exercise Habit Survey (EHS)

This scale consists of ten items (measured on a Likert Scale) which measures both the stability of circumstances which cue exercise behaviour (time of day, location, other people) and the constancy of exercise behaviour (Tappe & Glanz, 2013). Again, this measure is based on the cue-dependency of behaviour and doesn't measure the automaticity ingredient of habitual behaviours.

2. Recognition tasks

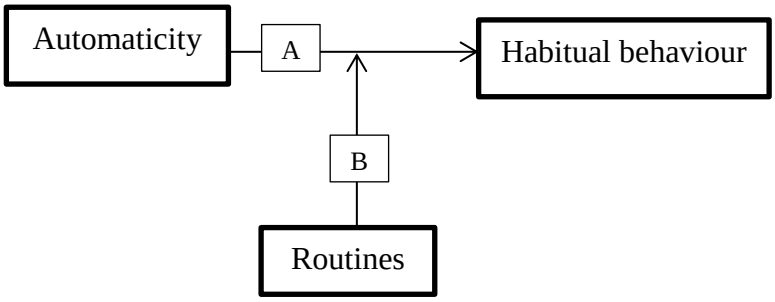
Behaviour recognition tasks may be seen as the gold standard for habit measurement as they measure the cue-response associations directly, and are not reliant on self-report (Danner et al., 2010). However, as prior knowledge of cues which initiate behaviour is required and a controlled environment to perform the tasks, they remain unfeasible in certain habit studies.

2.8.4 Habits, routine and automaticity

At this point within the thesis, it is important to highlight the differences between habitual behaviour, automaticity and routines, in order to set a clear context in which this piece of work has been conducted. Habitual behaviours are defined as a behaviour which is automatically instigated and/or executed by situational cues (Gardner, 2012). Automaticity takes the definition proposed by Bargh (1994) which stated that behaviour is conducted with absence of deliberation, absence of

awareness, absence of mental effort and absence of conscious control and is considered the main active ingredient of habitual behaviour (Gardner, 2012; Lally et al, 2010). Figure 2.7 helps to explain the interaction of routines, habitual behaviour and automaticity.

Figure 2.7 Explaining the interrelated connection between automaticity, habitual behaviour and routines



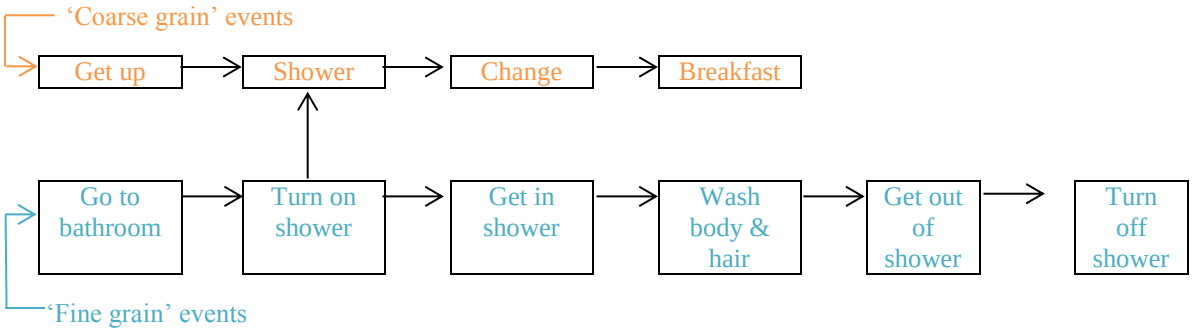
A. Automaticity is the defining feature of habitual behaviour (Gardner, 2012).

B. Routines may mediate the habit development by encouraging behaviour repetition to predetermined 'cues' (Zacks &Swallow, 2007).

Routines may help mediate the habitual process by facilitating the cue-automaticity development by increasing the chances of an individual constantly repeating the behaviour (Lally, Warde & Gardner, 2011; Judah, Gardner & Aunger, 2013; Aunger, 2007). Event Segmentation Theory (EST) argues that routines can be reliably organised into 'coarse grain' (less detailed) events and 'fine grain' (more detailed) events (Zacks & Swallow, 2007; Zacks & Tversky, 2001). For example, getting ready for work in the morning may be broken down into coarse and fine grain events (Figure 2.8). In addition to this, 'large task' boundary points exist between coarse events, and have been suggested as suboptimal points to insert the new behaviour

(Lally & Gardner, 2013; Aunger, 2007). Indeed, a study by Judah et al. (2013), which explored the psychological determinants of a habitual flossing intervention, showed that implementing a new behaviour at an event boundary was significantly less successful at producing a flossing habit, than placing it within the 'fine grain' events.

Figure 2.8 Coarse and fine grain events for getting ready for work in the morning



2.8.5 Habits and behaviour maintenance

One of the advantageous properties of habit is the theoretical proposed long term maintenance of behaviour which occurs when habits have been established (Rothman, Sheeran & Wood, 2009; Rothman, 2000). Indeed, a recent systematic review of behavioural maintenance theories (Kwasnicka et al., 2016) reports habit as a main theoretical theme and is discussed as the "most sustainable mechanism for maintenance" (pg 286) as behaviour is governed by automatic, system 1 (within the dual model) processes. As long as the individual encounters the established 'cue' to behaviour, conduct of such behaviour places little or no cognitive demands or self-regulation on the individual, and proceed without mental deliberation (Gardner, 2012; Strack & Deutsh, 2004; Bargh, 1992).

2.8.6 Habit within the behavioural change models

The thesis supports the recognition of the COM-B model used alongside habit formation theoretical approaches. To form a tooth brushing behaviour, individuals are required to be sufficiently motivated to perform oral health behaviours, capable of completing the behaviour and have an opportunity to repeat the behaviour in a stable context until it become habitual (Lally & Gardner, 2013). However, after oral health behaviours become automatic, behaviour instigation becomes governed by non-conscious, automatic, system 1 processes, which will dominant even when motivation and intention wane (Neal, Wood, Wu & Kurlander, 2011; Lally, Wardle & Gardner, 2011; Rothman, 2000). In this respect, habit formation approach builds on traditional models of behaviour change (synthesised into the 'COM-B' (capability, opportunity, motivation, behaviour) framework (Michie et al, 2011)), but adds the concept of 'context-dependent repetition', which develops habit associations (Lally et al., 2010).

2.8.7 Habitual interventions

A recent review of habit within health highlighted the limited interventional work within this area (Gardner, 2015). Eight studies were identified which have been designed to change or establish habits. These have included a number of behaviours such as physical activity (Carels et al., 2014; Lally et al., 2008; Jurg et al., 2006; Wood et al., 2005), dietary changes such as fruit consumption (Fleig et al., 2011; Carels et al., 2014; McGowan et al., 2013; Pearson et al., 2010; Lally et al., 2008), watching TV (Wood et al., 2005) and tooth brushing (Wind et al., 2005). Positive results have been demonstrated. For example, Lally et al., (2008) delivered a simple weight loss intervention (10 Top Tips) which incorporated a leaflet on how to form a

habit and some tips on changes for weight loss. At 8 weeks, the intervention groups had lost significantly more weight (mean 2.0kg) than the control (0.4 kg). Even more importantly, this weight loss within the intervention group continued at 32 weeks, with higher self-reported habit strength correlating with greater weight loss.

2.8.7.1 Habitual intervention in the dental context

Among these behavioural interventions which have been undertaken against a framework of habit formation theory, to date, to the best of the researcher's knowledge, only three interventional studies have applied habit theory to the dental context, one in relation to establishing habitual tooth brushing behaviour in children (Wind et al., 2005) and the remaining two focused on establishing habitual behaviour for flossing (Judah, Gardner & Aunger, 2013; Orbell & Verplanken, 2010 Study 3). The following section gives an overview of these interventional studies.

The first study, conducted by Wind et al. (2005) in the United States, implemented a tooth brushing intervention within the school environment, over a three year period, to encourage the establishment of habitual daily tooth brushing behaviour, under supervision. It recruited 296 fifth-graders into the quasi-experimental trial, with seven schools (141 children) allocated to the intervention arm, whilst the remaining eleven schools (155 children) formed the control arm. Measurements, based on TPB included subjective norms, descriptive norms and perceived behavioural control, were collected via questionnaires, alongside frequency of tooth brushing behaviour and habit, measured using the self-reported habit index (SRHI), at baseline, one and a half years into the intervention, at the end of the intervention (three years) and 1 year follow up. No measurement of socio-economic status was recorded. Results

demonstrated, at one year follow up, no significant change in frequency, cognitions or habit strength of tooth brushing behaviour. The constant repetition of behaviour within the stable environment (school context), was expected to result in the establishment of habitual behaviour. However, habitual (automatic) behaviour is cue dependent (McGowan et al., 2013; Lally et al., 2010) and perhaps either disruption of environment or the removal of the salient cue (for example teacher encouraging behaviour), resulted in the lack of habit formation long term.

Judah et al. (2013) explored the important psychological components for forming a flossing habit with a mixture of students and individuals held within the University College London (UCL) Psychology and Language subject pool. Results suggested that establishing flossing behaviour within an individual's routine is important and should be considered when developing future interventions. For example, those who flossed after tooth brushing rather than before formed stronger flossing habits. Interestingly, the mean habit score (ranging from 4 to 36), declined between 4 weeks post intervention to 8 months post intervention from 23.8 to 16.9. This is an interesting finding which suggested that habit decays over time. The authors offer two explanations for the decline suggesting contextual changes for student may have disrupted habits (Wood, Tam & Witt, 2005) or due to the lack of strongly established habits during the interventional phase, the behaviour always remained cognitively processed.

Finally, Orbell & Verplanken (2010, Study 3) encouraged 274 student participants to form an Implementation Intention (II) for flossing behaviour at the end of a questionnaire around flossing behaviour. Over time (4 weeks), results show the

intervention group (II) formed significantly higher flossing automaticity scores than the control, and this was significantly increased by having a strong intention to perform flossing.

In addition to these three studies, further studies have been completed around the application of Implementation Intention (II) to the dental context and importantly, demonstrated the effectiveness of II as a tool to help establish habitual behaviour, by ensuring a heightened awareness of the cue to the desired behaviour initiation. Although it must be noted, there was no measure of habit (or specifically automaticity) reported within these studies and therefore no conclusion about impact upon habit formation can be made (Schüz et al., 2009; Åstrøm, 2008; Sniehotta, Araújo Soares & Dombrowski, 2007; Schüz et al., 2006).

As well as the interventional studies, a cross-sectional survey, which expanded upon the qualitative findings from a previous research piece (Trubey, Moore & Chestnutt, 2014), was completed by parents of 296 children aged 3-6 years from a predominantly low socio-economic background. The survey reported stronger habitual tooth brushing behaviour (measured by the Self-Report Habit Index) with higher frequency of behaviour and when routines were more stable (Trubey, Moore & Chestnutt, 2015). These findings are in keeping with suggestions that tooth brushing behaviour occurs in a 'reoccuring sequence of behaviours' (Aunger, 2007).

2.9 Conclusion

This literature review highlights the importance of the establishment of oral health behaviours. The application of habit theory to interventions for behavioural change

within the dental context has been limited to only three which focus on flossing behaviour and tooth brushing in children. This suggests that the application of habit theory would be novel and innovative, and perhaps will help to ensure long-term behavioural maintenance of desirable behaviours such as tooth brushing. Studies involving adults oral health behaviours are particularly needed, as are more studies involving vulnerable populations. There have been no previous studies in this field involving UK adults as participants.

Chapter 3: Systematic review of the effectiveness of interventions using a mechanism of cue-automaticity to increase the uptake of preventive healthcare services

3.1 Overview and rationale for the study

As the literature review chapter noted, interest in the role of automatic behaviour in the instigation and maintenance of oral health behaviours is beginning to grow, most notably in relation to the promotion of daily flossing (Judah, Gardner & Aunger, 2013; Orbell & Verplanken, 2010). Preliminary results are suggesting that forming habits may be an effective intervention approach to establishing and maintaining desired oral hygiene behaviours. However, the same approach has yet to be explored in relation to less frequent, more complex behaviours such as preventive dental visiting. It raises the question as to whether the use of habit theory to prompt dental visiting is sufficient to establish a pattern of habitual behaviour – given the extended timescales involved and its infrequent nature. To help explore this gap in knowledge, this study systematically reviewed evidence from the wider healthcare context, and considered whether there is evidence that cue-automaticity interventions are effective for other similar types of preventive visiting behaviour such as attendance for cervical smears, examinations, eye tests etc. The study also identified the design features of these types of studies in order to help inform the design of cue-automaticity intervention in our area of interest (preventive dental visiting).

The rest of this chapter reports the systematic review undertaken. The rationale for conducting a systematic review is presented followed by the aim and research

questions, methodology and results. Finally, within the discussion section, limitations of the study are noted alongside future recommendations for practice.

3.2 Systematic reviews

Systematic reviews allow researchers to produce an evidence-based answer to a given research question by gathering together and synthesising all available evidence from literature. This body of evidence may then be used to inform and influence clinical practice, such as delivery of interventions for health and policy changes. Due to this, it is important that systematic reviews are reported in a transparent and reproducible manner, and to aid this, a number of evidence-based guidelines have been produced. One example is the PRISMA Statement which consists of a 27 item checklist to ensure rigor in reporting of systematic review and meta-analysis (Moher et al., 2009).

Therefore, the research question proposed within this study is best answered using systematic review methodology, as it allows for the collection of all knowledge within the wider healthcare literature around this intervention type. In order to ensure transparency and reproducible reporting within this review, the PRISMA Statement was used.

3.3 Aim and research questions

The aim of this study was two-fold:

1. To assess the effectiveness of interventions containing a component of cue-automaticity that aim to improve the uptake of preventive healthcare.
2. To consider how this approach might be applied to preventive dental visiting.

The following research questions were set:

1. Are interventions containing a component of cue-automaticity that aim to improve the uptake of preventive healthcare effective?

2. Can this type of approach (cue-automaticity) be applied to the preventive dental visiting context?

3.4 Methods

3.4.1 Criteria for included studies

a. Types of studies:

Study design was limited to randomised controlled trials (RCTs), quasi randomised controlled trials, pilot studies, feasibility studies, controlled randomised trials, cluster randomised trials. Since the aim of the study was to assess the effectiveness of interventions, the focus on types of study was RCTs & quasi RCTs because these represent gold standard evidence where confounding is taken into account by randomisation. Pilot and feasibility studies were also included in the search to enable this to be as broad as possible, to help inform the design of later studies in the dental context, and with the intervention study the researcher would contact authors to see whether pre-published RCT results were available. Studies were required to have an intervention which used a component of habit formation to improve the uptake of preventive healthcare services. Studies which included documentation of cue-automaticity or linked the intervention to the production of automated behaviour were defined as including habitual formation theory. Studies were not restricted by language or publication date.

In relation to this:

'Preventive' was defined as services based on the principle of anticipatory action such as vaccination, health checks etc, where disease or ill health symptoms are not yet apparent.

and

'Health care services' was defined as any type of publicly or privately funded service which would benefit people's health.

b. Types of participants

Under the Children Act 1989 (Legislation, 2018), a child is defined as someone who has not yet reached their 18th birthday, although it is acknowledged that this age may vary dependant on different circumstances (e.g. legal age of consent). Therefore, participants aged 18 years or over and eligible to use preventive healthcare services were included. Studies of male, female or both were considered for inclusion, where appropriate.

c. Types of interventions

Studies which used an intervention designed to increase the uptake of preventive healthcare services using a component of the habit formation model or theory (i.e. cue-automaticity) as a framework for intervention design were included. In addition, studies were required to contain a control group (standard care) or at least one alternative intervention group (based on a model or theoretical basis) to which the efficacy of the intervention could be compared. No limitation was placed on the

intervention setting or the level at which the intervention targeted (for example community or individual level interventions).

d. Types of outcome measures

In order to determine the extent of behavioural change resulting from the intervention, a mixture of outcome measures were considered:

i. Primary outcome measure

Attendance for preventive healthcare service use, which was measured either by a self-reported behavioural attendance outcome or observed measures of behaviour (e.g. through examination of healthcare records for attendance).

ii. Secondary outcome measure

As this body of work was interested in the effectiveness of interventions using cue-automaticity to increase healthcare service usage, data on the following outcomes were also gathered. These include changes from baseline to follow-up in:

- Automaticity (measured via the Self-Reported Habit Index (SRHI) or another similar measure)
- Cognitive variables (including self-efficacy, perceived behavioural control, intention, motivation etc)
- Clinical status outcomes (including changes in detection of disease etc)
- Financial outcomes (including the cost-effectiveness of the intervention)

3.4.2 Search methods for identification of studies

a. Electronic searching

To locate studies for inclusion, a detailed search strategy was devised for use on each of the following databases: Cochrane Database of Systematic Reviews – CDSR

(Cochrane), Cochrane Central Database of Controlled Trials – CENTRAL (Cochrane), The Cochrane Oral Health Group's Trials Register (2015), MEDLINE (Ovid), MEDLINE In-Process (Ovid), EMBASE (Ovid), HMIC Health Management Information Consortium, PsycINFO, ASSIA, ERIC, Web of Science (from 1898 to current) and Scopus.

The use of these healthcare and psychological databases allowed for a thorough exploration of the published literature around this topic. A detailed search strategy was constructed using terms from key papers with each search strategy tailored to each of the eleven databases. An example of the comprehensive search strategy used for MEDLINE (Ovid) is included within Appendix 1. Key papers which informed search strategy terms included those which present habit theory (Gardner, 2015; Lally et al., 2010).

b. Citation snowballing

Forward citation searching included screening all papers which cited the electronic searching inclusion papers, whilst backward citation searching screened all papers cited within included papers from the electronic search. The process of citation snowballing is documented within Appendix 2.

c. Personal contact

The author(s) personally contacted researchers currently working within the topic area of 'habit' in relation to health behaviours (via e-mail) to receive any further information of additional or unpublished studies that may have been eligible for inclusion.

3.4.3 Data collection and analysis

a. Study selection

Title and abstract screening was conducted by two reviewers (HR) and (SW) with disagreements resolved by a third reviewer (RH). To ensure intra-rater reliability, 20% of papers were re-screened by each reviewer. After title and abstract screening, HR & SW completed full paper screening. Again, disagreements for inclusion was resolved by a third reviewer (RH). Papers deemed unsuitable were rejected, with the reason documented within Endnote. Relevant studies indicated via citation snowballing or personal contact with professionals were assessed in the same way.

b. Data extraction

A data extraction form was conducted using the Consolidated Standards of Reporting Trials (CONSORT) statement checklist (Consort, 2018), into structured data extraction tables and grouped according to the preventive healthcare services type (for example, cancer screening or vaccinations). Data extraction tables were piloted to ensure their suitability, after which, one reviewer (HR) extracted all relevant data. Data extraction was double checked by a second reviewer (SW), with any discrepancies resolved by a third assessor (RH). Information on the following was extracted:

1. General study information including author, title, country or origin and year of publication, publication status (and, if published, in which journal), statement of ethical approval, funding source and language.
2. Study characteristics and descriptive data including sample size, numbers of participants randomised to each group, number of participants remaining at follow up, randomisation method, allocation concealment and blinding.

3. Participants characteristic including age, gender, ethnicity/race and measure of baseline health.

4. Intervention characteristics including habit theory used for intervention design, theoretical basis of alternative intervention group(s), follow-up period, number of sessions, type of intervention (individual or group) and location of delivery, details on intervention provider (e.g. qualifications, professional status).

5. Outcome measures, results and conclusions including baseline and follow-up results, outcome measures and reported outcome measures and conclusions drawn.

c. Data synthesis

As the data from this systematic review was heterogeneous in terms of population sample and outcome measures (Chi^2 = 23.64, df = 6 (p = 0.0006); I^2= 75%), it was decided that it would not be appropriate to undertake a meta-analysis. A narrative summary of the data was therefore produced. Alongside this, odd ratios were also calculated from the data to document the probability of using preventive healthcare services relative to the probability of non-attendance.

d. Quality assessment

Quality assessment was completed for both the included studies and for the quality of this systematic review itself. For included studies, the term quality was defined as: 'The degree to which a study employs measures to minimise bias and error in its design, conduct and analysis' (Khan et al., 2003). As all included studies within this review were of a RCT design, a design-specific tool was used. The risk of bias tool from the Cochrane Handbook (Higgins & Green, 2011) was used due to its detailed approach and validation and was completed by two assessors (HR and SW). It

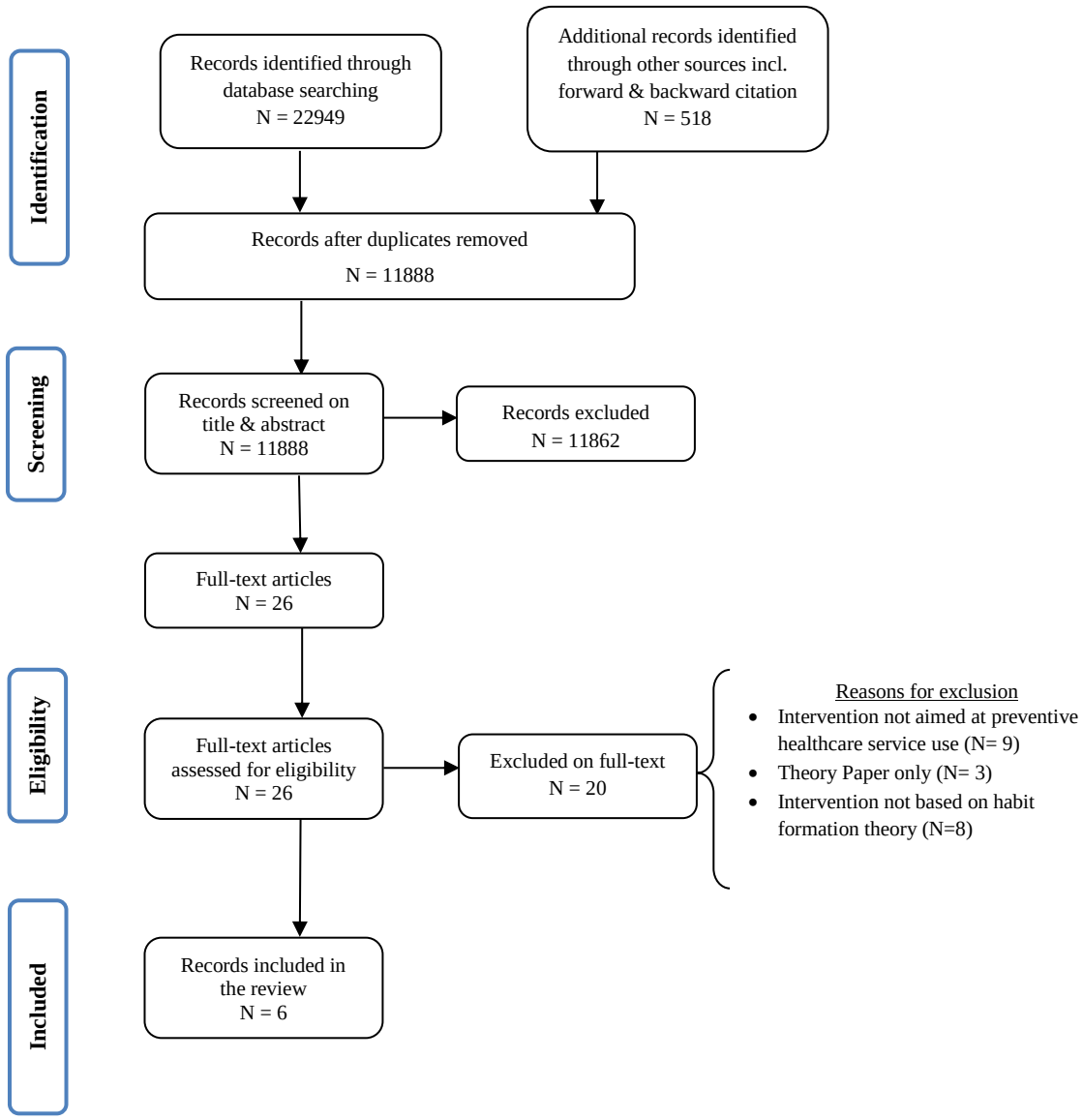
provided a checklist for assessing the quality of included studies and helped to generate a picture of the overall quality of each study. Studies were classified as being of high, low or unclear risk of bias for the seven pre-determined domains. These include: sequence generation; allocation concealment; blinding of participants and personnel; blinding of outcome assessment; incomplete outcome data; selective outcome reports and other issues. The systematic review itself was also quality assessed using the AMSTAR quality assessment tool (Shea et al, 2007) to ensure its transparency and reproducibility.

3.5 Results

3.5.1 Search results

Electronic searching alongside backward and forward citations identified 11,888 titles and abstracts. Appendix 2 documents the forward and backward citation search results. Twenty six full papers were screened for eligibility of which twenty were excluded. Figure 3.1 gives a PRISMA diagram with reasons for exclusion. These include: interventions not aimed at preventive healthcare service use (nine studies), theory paper only (three studies) and intervention not based on habit formation theory (eight studies).

Figure 3.1 PRISMA flow diagram of study inclusion



3.5.2 Overview of included studies

The six included studies were of a randomised controlled trial (RCT) design and were all published between 2000 and 2014. Included studies were concerned with either increasing the uptake of vaccinations (Hepatitis B (Vet et al., 2014) and influenza (Milkman et al., 2011)) or increasing the attendance for cancer screening programmes (colorectal (Neter et al., 2014; Greiner et al., 2014), cervical (Sheeran & Orbell, 2000) and breast (Rutter et al., 2006)). Length of follow up ranged from 3 to

6 months. One study did not report length of follow-up (Rutter et al., 2006), however, clarification was achieved from the authors via email. Table 3.1 summarises the details of the included studies and is a summary of the data extraction tables constructed for this review.

Table 3.1 Summary of included papers

Study, Year, Country, Recruitment population	Participant demographic	Participant characteristics	Outcome and other measures	Intervention	Control	Method of delivery	Results	Conclusion
Preventive healthcare service: Vaccinations								
Milkman et al, 2011 USA n=3272 Employees at a large Midwestern utility firm	Age 51.1 years ± 8.1 (mean) Gender 72.5% Male 27.5% Female Ethnicity /Race 76.6% Caucasian 20.5% African-American 2.8% Asian	Inclusion • Vaccination indicated by CDC guidelines: 1. Individuals 50 years of age or older OR 2. Those with chronic health conditions that increase the risk of influenza related complications	Outcome Influenza vaccination – receipt of a seasonal influenza vaccination at one of the firm's on-site clinics Baseline N/R	Date Plan Condition Control + prompt to write down date employees planned to get their vaccine Time Plan Condition Control + prompt to write down date & time employees planned to get their vaccine	Info about workplace vaccination clinics (locations & times) Info on importance of receiving influenza vaccine	Email	1.5% higher vaccination rate than control – NS (unadjusted OR 1.12 95% CI 0.92 to 1.35). 4.2% higher vaccination rate than control – significant (unadjusted OR 1.19 95% CI 1.01 to 1.40)	II intervention significantly increased influenza vaccinations, but only when both the date & time planned.
Vet et al, 2014 Netherlands n=616 Online participants	Age 32.6 years ± 12.4 (mean) Gender 100% Male Ethnicity/Race 95% Dutch 5% Ethnic minority	Inclusion • Male • Had sex with a man in previous year • Not infected with HBV • Not previously vaccinated against HBV • Did not immediately make a HBV vaccination appt online • Intented to make a vaccination apt at some point	Outcome Receipt of HBV vaccine – as recorded on HBV vaccination register Baseline - Goal intention -II complete - ness	Provide details of when, where & how they would make HBV vaccine appt. Either email or printed II given with info about HBV vaccine sites.	General info including contact details of Public Health Services offering HBV vaccines	Online	Strong intention more likely to have obtained HBV vaccination than men with a weak intention ($p<0.01$) Significant association between II & HBV vaccination (unadjusted OR 2.73 95% CI 1.38 to 5.4) Association between intention strength & completeness of II ($p<0.05$)	Having a strong goal intention to obtain HBV vaccine and forming a complete II, each significantly & independently increase likelihood of MSM obtaining HBV vaccination.

							Completeness of II significantly associated with HBV vaccination uptake ($p<0.001$)	
Preventive healthcare service: Cancer screening								
Greiner et al, 2014 USA n=470 Attendees at 9 safety-net clinics	<u>Age</u> 55 years (median) <u>Gender</u> 36.4% Male 63.6% Female <u>Ethnicity /Race</u> 27% Hispanic 42% Non-Hispanic African-American 28% Non-Hispanic white 3% Other	<u>Inclusion</u> • Patients aged ≥ 50 years • Have a provider visit on enrolment day <u>Exclusion</u> • Income > 150% federal poverty level • No home address • No working phone • Received faecal occult blood test of FIT within last year • Sigmoidoscopy or barium enema within last 5 years • Colonoscopy within last 10 years • Acute medical illness • Reported current GI bleeding • History of colon polyps • History of CRC • First-degree relative with CRC prior to age 60 years • Inherited polyposis/nonpolyposis syndrome • Inflammatory bowel disease	<u>Outcome</u> Colorectal cancer screening – completion of either FIT or screening colonoscopy <u>Baseline</u> -PAPM staging -Perceived susceptibility to CRC -Self-efficacy for CRC screening -Cancer fatalism	Received info & education on CRC screening. Completed II around CRC screening planning. Given print out of II Those "deciding to" pursue screening test were given either an FIT kit or colonoscopy scheduling info & bowel prep materials before leaving clinic.	Received info & education on CRC screening. Given questions and print out on diet, exercise & health living. Those "deciding to" pursue a screening test were given either an FIT kit or colonoscopy scheduling info & bowel prep materials before leaving clinic	Touch-screen computer	Individuals who completed an II had higher odds of completing CRC screening than comparison (AOR=1.83). Higher self-efficacy were more likely to complete CRC screening (AOR=1.57)	II approach can contribute to successful completion of CRC screening even among very low-income & diverse primary care pop[n]

		• Another household member enrolled in study • Cognitive impairment						
Neter et al, 2014 Israel n=27633 HMO-insured members	<u>Age</u> 62.31 years ± 6.66 (mean) <u>Gender</u> 43.8% Male 56.2% Female <u>Ethnicity /Race</u> N/R	<u>Inclusion</u> • Performed FOBT test in last year • No inflammatory bowel disease or malignancy • No colonoscopy within previous 3 years • Insured member	<u>Outcome</u> Colorectal cancer screening - completion of FOBT test <u>Baseline</u> -Intention -Perceived efficacy -CRC knowledge -Risk perception -Perceived health	Mailed FOBT test kit &leaflet containing a instructions to write down when, where & how to complete the FOBT test	Mailed info leaflet & FOBT kit	Post	Individuals who completed an II were significantly more likely to complete FOBT testing than those in the control (unadjusted OR 1.18 95% CI 1.12 to 1.24)	II technique is useful in increasing adherence to CRC screening, even in a mailed form rather than a face-to-face situation
Rutter et al, 2006 UK n=2082 Patients on NHSBSP screening database	<u>Age</u> 56.1 years (mean) <u>Gender</u> 100% Female <u>Ethnicity /Race</u> 98.6%White British	<u>Inclusion</u> Members of 2 screening cohorts from Kent, England	<u>Outcome</u> Breast cancer screening – as recorded by screening centre <u>Baseline</u> -Intention -Beliefs -Subjective norm -Perceived behavioural control	<u>Intervention</u> Postal questionnaire measuring health behaviours, beliefs about attending for breast screening & details of their demographic background. Also a section to formulate II to overcome 3 potential obstacles 1. Changing inconvenient appointment 2. Arranging transport 3. Negotiating time off work prior to their invitation to screening.	Sent invitation for screening.	Post	NS (unadjusted OR 0.92 95% CI 0.68 to 1.24) However, women who made a plan for negotiating time off work were significantly more likely to attend than those who did not or for whom planning was irrelevant ($p<0.01$)	II did not lead to an overall increases in attendance for breast screening.

				<u>Assessment-only</u> Postal questionnaire measuring health behaviours, beliefs about attending for breast screening & details of their demographic background, prior to their invitation to screening.			NS (unadjusted OR 0.99 95% CI 0.72 to 1.38)	
Sheeran et al, 2000 UK n=217 Patients at a single medical practice	<u>Age</u> 40.62 (SD=11.69) <u>Gender</u> 100% Female <u>Ethnicity /Race</u> N/R	<u>Inclusion</u> Due for a cervical smear test during a 3-month period	<u>Outcome</u> Uptake of cervical smear test <u>Baseline</u> -Attitudes -Subjective norms -Perceived behavioural control -Intention	Standard postal reminder to attend for cervical smear. Then a postal questionnaire concerning their views of cervical smear test and asked to form an II specifying when, where & how they would make an appointment to go for cervical smear test.	Standard postal reminder to attend for cervical smear. Then a postal questionnaire concerning their views of the cervical smear test.	Post	Women who formed II were significantly more likely to attend for their appointment (unadjusted OR 4.83 95% CI 1.64 to 14.22)	Forming II to make an appointment to attend increases likelihood of attendance – even when participants strongly intend to achieve their goal.

3.5.3. Intervention details of included studies

All six included studies incorporated an Implementation Intention (II) (i.e. 'if-then' plans) component as part of the intervention. Table 3.2 provides extracted detail of the cue-automaticity component from each study. In three studies, the 'if-then' plan was combined with other intervention components such as information about benefits of attendance for screening (Milkman et al., 2011; Neter et al., 2014; Greiner et al., 2014). 'If' components were all personally predetermined by participants and consisted of a combination of dates, times and/or places. For example, Milkman et al. (2011) emailed employees, at a large utility firm, one of three different emails about workplace vaccination clinics. All emails contained educational information about where and when influenza vaccinations would take place at the firm. The two intervention arms both encouraged participants, via e-mail, to construct an II. The first encouraged forming II round the date they planned to receive their vaccination, whilst the other encouraged the record of both the date and time.

Table 3.2 Documentation of intervention forming cue-automaticity or link it to the production of automated behaviour by cue initiation

Study, Year	Intervention details
Vet et al, 2014	Implementation Intention (II) *"… The resulting increased cognitive accessibility of the specified situational cue facilitates the detection of an attention to this cue. In addition, forming an implementation intention is thought to automate the execution of a behavioural response…" pg 123*
Milkman et al, 2011	Implementation Intention (II) *"… Simply asking people to develop such a plan, or an "implementation intention," is all that is necessary to trigger an association between the desired behaviour and a concrete future moment…" pg 10415*
Sheeran et al, 2000	Implementation Intention (II) *"…Rather, "the underlying theory is that by forming implementation intentions people pass on control of goal-directed activities from the self to the environment. The intended behaviour is subject to external control through the environmental cues specified in one's implementation intention … when these cues … are encountered, they are expected to prompt the intended behaviour…" pg.284*
Neter et al, 2014	Implementation Intention (II) *"…The automation transfers goal-directed behaviour from effortful, conscious control into reacting to situational cues…" pg.274*
Rutter et al, 2006	Implementation Intention (II) *"… implementation intentions "pass on control of goal-directed activities from the self to the environment…" pg.128*
Greiner et al, 2014	Implementation Intention (II) *"…II can lead to initiation of action even when people are stressed…" pg. 704*

In addition, the importance of full completion of the II (rather than partial completion) had a significant effect in two studies. Vet et al. (2014), recruited men online via a number of different websites for men who have sex with men (MSM). Consented participants were asked to complete online an II about when, where and how to make an appointment for Hepatitis B vaccination. Those who provided a valid, registered response about when, where and how were classified as having a complete II. Sixty per cent of participants formed complete II plans and analysis showed that completeness was significantly associated with HBV vaccination uptake (unadjusted OR 3.01 95% CI 1.32 to 6.85). The other study, by Milkman et al. (2011), showed the II intervention significantly increased influenza vaccinations, but only in the intervention arm where both the date and the time were documented (unadjusted OR 1.19 95% CI 1.01 to 1.40).

3.5.4 Interventional effect on primary outcome

Five studies showed a significantly positive increase in preventive health service usage (Table 2.1). For example, Sheeran et al. (2000), who incorporated an II intervention at the end of a postal questionnaire about cervical cancer screening, reported 92% of interventional individuals attended for cervical cancer screening compared to 69% of the control (unadjusted OR 4.83 95% CI 1.64 to 14.22). Neter et al. (2014) posted a fecal occult blood test (FOBT) kit to HMO-insured members with either an information leaflet (control) or a leaflet containing II instructions to write down when, where and how they would complete the FOBT test (intervention). Results showed individuals within the intervention group were significantly more likely to complete and return the FOBT test than the control (unadjusted OR 1.18 95% CI 1.12 to 1.24). Another study by Greiner et al. (2014) incorporated, via computers within a healthcare setting (safety-nets), information and education on colorectal cancer (CRC) screening. Participants in the intervention group completed an II around when, where and how they would complete CRC screening, and were given a printout copy of their individualised II to take home. The control group were asked questions and given printout information on diet, exercise and healthy living. Results showed that those individuals who completed the II intervention had higher odds of completing CRC screening compared to controls (AOR=1.83).

Only one of the six included studies did not show a significant intervention effect (Rutter et al., 2006). This study incorporated an II intervention component via a postal questionnaire aimed at increasing the uptake of attendance for breast cancer screening. The II addressed three key barriers to attendance; namely changing an appointment, travelling to the screening unit and arranging time off work.

Participants were required to form II for all three key barriers and return the questionnaire. Results showed a non-significant II intervention effect (78.9%) compared to controls (80.3%) (unadjusted OR 0.92 95% CI 0.68 to 1.24). A possible explanation for the non-significance could be a ceiling effect of high attendance in the control condition. Alternatively, the observed lack of intervention effectiveness may be due to the fact that IIs were focused around antecedents (barriers) to the behaviour, rather than on the visiting behaviour itself.

3.5.5 Interventional effect on secondary outcomes

Just one study explored the differential interventional effects of a cue-automaticity intervention by SES background. Participants in the study by Neter et al. (2014) were from a range of SES backgrounds (based on clinic SES), with the study showing that intervention effects were consistent across the SES spectrum. In addition, Greiner et al. (2014) delivered the intervention to individuals from a low SES background (income >150% of the Federal Poverty Level), via recruitment from nine different safety-net clinics within the US. They also demonstrated a positive increase in uptake of colorectal cancer screening with an II component (54%) compared to an education only intervention (unadjusted OR 1.18 95% CI 1.12 to 1.24 (42%). The remaining four studies did not consider SES as an explanatory variable.

No outcome measures of automatic behaviour, such as the Self-Report Behavioural Automaticity Index (SRBAI), were reported in any of the included papers. A number of different baseline variables were measured such as: behavioural intention, self-efficacy, perceived susceptibility and perceived behavioural control. Of these variables, only intention to perform the behaviour was found to be significantly

associated with intervention effectiveness (Vet al et., 2014; Neter et al., 2014; Sheeran & Orbell, 2000; Rutter et al, 2006). For example, Vet et al. (2014) showed that when individuals had strong intentions (based on a 5 point Likert-Scale), they were significantly more likely to obtain HBV vaccinations than those with weak intentions (23.4% vs. 7.3%).

3.5.6 Quality assessment

Two studies (Greiner et al., 2014; Rutter et al., 2006) were deemed to be of high risk of bias while the remaining four studies were of unclear risk (Table 3.3). The AMSTAR quality assessment for this systematic review is reported in Figure 3.2.

Table 3.3 Risk of bias of included studies (according to the Cochrane Risk of Bias Tool)

	Greiner 2014	Milkman 2011	Neter 2014	Rutter 2006	Sheeran 2000	Vet 2014
Random sequence generation	U	U	U	H	U	U
Allocation concealment	U	L	U	H	U	U
Blinding of participants & personnel	H	U	U	U	U	L
Blinding of outcome assessment	L	L	L	L	U	L
Incomplete outcome data	L	L	L	L	L	L
Selective reporting	L	L	L	L	L	L
Other bias	U	L	L	L	L	L

Key: L = Low risk, H = High risk, U = unclear risk

Figure 3.2 AMSTAR quality assessment

1. Was an 'a priori' design provided? Yes
   Although the protocol wasn't published, there was one in place prior to commencing the systematic review.
2. Was there a duplicate study design and data extraction? Yes
   Two people (HR & SW) reviewed the title and abstract / full paper screening.
   The same process was also implemented for the data extraction part.
   Disagreements were resolved via a third reviewer (RH).
3. Was a comprehensive literature search performed? Yes
   Over two electronic sources were searched. The report includes the years and databases used, as well as an example search strategy included in the appendix.
4. Was the status of publication (i.e. grey literature) used as an inclusion criterion? No
   The author did not search grey literature.
5. Was a list of studies (included and excluded) provided? Yes
   This was provided in the protocol and in the methods section.
6. Were the characteristics of the included studies provided? Yes
   Data was extracted into data extraction tables and a summary table of data extraction is provided in Table 1.
7. Was the scientific quality of the included studies assessed and documented? Yes
   The Cochrane risk of bias tool was used as a quality assessment
8. Was scientific quality of the included studies used appropriately in formulating conclusions? Yes
   Limitations of the quality of the studies is documented and discussed.
9. Were the methods used to combine the findings of studies appropriate? Yes
   An assessment of homogeneity was made and decision made to not complete meta-analysis.
10. Was the likelihood of publication bias assessed? Yes
    Although a funnel plot or statistical test wasn't reported, note was made that this wasn't appropriate because only 6 studies were included within this systematic review.
11. Was the conflict of interest included? No
    Although within the manuscript published the conflict of interest is noted.

3.6 Discussion

The aim of this systematic review was to assess the effectiveness of interventions, containing a component of cue-automaticity, to improve the uptake of preventive healthcare, and to consider how this approach might be applied to preventive dental visiting. Given that results show only six included studies, and all incorporated II as the intervention tool, this suggests that this approach has been relatively unexplored. Five of six included studies showed a significant interventional effective at increasing preventive healthcare use, suggesting that whilst this area of research may be relatively new, it may offer an effective way to improve preventive health care service uptake. An important note of caution however should be added when

interpreting these results - none of these studies were rated as high quality, with two studies reported as high risk of bias and the remaining four of unclear risk.

Dental visiting is an infrequent, complex behaviour. While included studies also addressed infrequent, complex behaviours such as attendance for breast cancer screening (yearly – every 3 years), influenza vaccination (yearly) and cervical cancer screening (every 3-5 years), there is a lack of studies which incorporate long term follow-up (the maximum length of follow-up in included studies was six months). This therefore raises a question as to whether included interventions (all of which incorporated an II intervention component) can be truly seen as establishing cue-automaticity in the context of complex, infrequent health behaviours. II interventions, in this setting, may increase behaviour by heightening the mental accessibility of an opportune moment to act rather than establishing a memorable link between a particular cue and behaviour. Therefore, the active mechanism within these interventions requires further exploration, and should include determination as to whether cue-automaticity has been established using a long term follow-up strategy.

A number of different cognitive variables were extracted from the data with behavioural intention being the only significant variable associated with intervention effectiveness. This is in keeping with the habit theory proposed, that intention to perform the behaviour is the first 'step' in establishing habitual behaviour (Lally & Gardner, 2013; Gardner, Lally & Wardle, 2012). Therefore, when consideration is given to the development of future interventions targeted towards increasing the

uptake of preventive dental service use, a focus should be given to the importance of intention to perform the behaviour within the intervention.

The results section also gave consideration to the impact these types of interventions may have upon individuals from a low SES background. Although people who live in poverty are most in need of regular, preventive dental care, they are often the least likely to take it up (Petersen et al., 2005; Thomson et al., 2010; Office of National Statistics, 2009; Petersen, 1990; Donaldson et al., 2008; Watt, 2007) and lower rates of preventive dental visiting are found to account for at least some of the reduced levels of oral health at the lower end of the SES visiting spectrum (Thomson et al., 2010; Sanders et al., 2006). Since studies show that living in poverty places such strains on internal resources that cognitive processing capacity is effectively reduced (Mani et al., 2013; Mauraven & Baumeister, 2000), interventions which establish automatic behaviour may be beneficial in addressing socio-economic related health inequalities. This is because automatic behaviour is relatively un-demanding of cognitive processes (Strack & Deutsch, 2004). Thus interventions which promote preventive dental visiting are one way in which health inequalities may be reduced, and cue-automaticity is one way in which such interventions may be designed. Whilst only one included study focussed on low SES participants exclusively and another explored the gradient of improvement across the SES spectrum, the impact of this type of psychological intervention across the SES gradient remains to be determined. However, the limited current evidence of this review suggests that a uniform impact across the SES gradient may be likely (Neter et al., 2014; Greiner et al 2014). This outcome will depend, however, on the extent to which full adherence

to the II intervention is consistent across all SES groups as completeness of II may impact significantly on preventive behaviour.

The intervention format of the one study where no evidence of effectiveness was found (Rutter et al., 2006) suggests that II interventions maybe more effective when they focus on the behaviour itself rather than around antecedent steps to attendance, such as how one might travel to an appointment. This suggests that within the dental visiting context, the II intervention might be most effective when it documents where (i.e. which dental practice you will contact), when (i.e. which date and time you will make contact with the dental practice) and how (i.e. telephone / email /face-to-face) patients will make an appointment, rather than overcoming barriers (such as arranging time off work) for dental attendance.

Certainly the infrastructure around dental appointment system may lend itself to being used to incorporate II plans when making appointments for check-ups, since reminder cards and postcard messages have previously been used successfully to increase attendance (Patel et al., 2000; Reekie & Devlin, 1998). The addition of an II intervention to the end of such reminder prompts may assist individuals with an intention to attend, by heightening their awareness to the predetermined cue associated with attendance and establishing a mental link between the specific cue and attending.

3.6.1 Study limitations

Finally, a number of study limitations should be acknowledged. First, all of the preventive healthcare services included within the review were free for the individuals from the point of contact. Although this is true in certain situations, such as those who qualify for free dental treatment (e.g. pregnant women in the United Kingdom), treatment cost presents a substantive filter to preventive dental attendance (Harris, Pennington & Whitehead, 2017). It is possible that this factor might prove so great a barrier as to impact the efficacy of cue-automaticity interventions in the dental context. Secondly, preventive healthcare services within the review included cancer and Hepatitis B, which carry a significant mortality and morbidity risk. It is likely that this heightens individual's intentions to conduct this type of preventive behaviour, making this form of psychological intervention more effective. It is unclear therefore whether this efficacy would translate into the less urgent, dental context.

3.7 Conclusion

This systematic review has highlighted that although it is a relative unexplored area of research, initial results are promising the effectiveness of cue-automaticity interventions in increasing uptake of preventive healthcare. In relation to future intervention design, a number of important considerations have been highlighted. These include ensuring intention for behaviour is addressed within the intervention and encouraging completeness of II components when intervention is delivered. However, more work is required to understand the active mechanism of II interventions, over the long term, and their impact across the SES gradient.

This systematic review, combined with Gardner's (2015) review of the terms of habit, allows a clear scope of the current position of habit theory application to the dental context. This systematic review has been published in the Community Dental Journal (Appendix 3).

Chapter 4: A qualitative study to identify the nature of tooth brushing behaviour

4.1 Overview

As the literature review documented (section 2.5.1), regular twice daily tooth brushing, with fluoridated toothpaste, is essential to maintaining good oral health (Wong et al., 2011; Attin & Hornecker, 2005). Despite the relative simplicity of this behaviour and its low cost to implement (tooth brush and toothpaste can be bought for as little as 75 pence), many individuals continue to brush less than the twice daily recommendation (Joshi et al., 2018; Office of National Statistics, 2013; Huebner & Riedy, 2010) and this can contribute towards an individual's poor oral health.

Also within the literature review (section 2.8.7.1), it was noted that emerging literature is beginning to suggest that people develop a habitual behaviour towards tooth brushing (Newton and Asimakopoulou, 2017; Innes and Manlon, 2017), but this concept is currently mainly a theoretical proposition and requires further exploration. Moreover, a distinction between regular and habitual behaviour has been drawn, because even where behaviour is performed regularly, this may not translate into habitually driven behaviour but remain cognitively processed (Kurz et al, 2015; Verplanken, 2010). For example, although individuals may repeatedly keep a journal, the behaviour is generally considered to be performed cognitively, i.e. with conscious effort. Therefore, before the consideration of the implementation of a habitual tooth brushing intervention, it is important to explore whether indeed this behaviour is performed in an automatic manner.

Therefore, this study aims to address the gap in the knowledge around the nature of tooth brushing behaviour. Using qualitative methods, this piece of work asks the research question: 'Is tooth brushing behaviour habitual in adults? And if so, what are the salient cues (prompts) which initial tooth brushing and motivators/rewards (drivers of behaviour repetition) which allow for sufficient behavioural repetition to establish habitual behaviour?'

4.2 Methodological approach

In order to gain a comprehensive, in depth understanding of tooth brushing behaviour from an individual perspective, it was decided to explore this research question using qualitative rather than quantitative methods (Stewart et al., 2008). Quantitative approaches, such as questionnaires, would be insufficient to capture the wealth of nuanced information gathered, even if open ended questions are used. They are inflexible to the emerging data and do not explore different concepts of data as they form/develop (Ritchie & Lewis, 2013; Creswell, 2012). Therefore this research piece is best explored using qualitative methods, allowing an in-depth discussion around tooth brushing behaviour to identify the features of its nature.

This type of research question was judged to be more easily answered using generated rather than naturally occurring data. Generated data involves 'reconstruction and requires re-processing and re-telling of attitudes, beliefs, behaviour or other phenomena' (pg 36, Ritchie & Lewis, 2013; Bryman 2001), while naturally occurring data is 'data which is an 'enactment' of social behaviour in its own social setting, rather than a 'recounting' of it generated specifically for the research study (pg 34, Ritchie & Lewis, 2013). A number of different methods could

therefore be appropriate to address this research question: biographical methods; individual interviews; focus groups or group discussions. Biographical methods 'use life stories, narratives and recounted biographies to understand the phenomena under study' (pg 36, Ritchie & Lewis, 2013).This method was judged to provide an insufficient level of detail to enable a fine-grain examination of a single behaviour (tooth brushing) particularly where the phenomenon under examination was being approached using an a priori theoretical construct (habit formation theory). While focus groups are advantageous as they allow interactions with other participants which can facilitate active participation and they also encourage an open environment for exploration of different topics (Rabiee, 2004; Kitzinger, 1994); however, focus groups have been deemed to tend to cause a 'polarization effect' (Morgan, 1996) whereby emerging data from the group may tend to be guided by a consensual group opinion, rather than taking forward a group of individual opinions. They also have a limited ability to explore, in depth, an individual's personal routine and structure. This information is essential to answer the research question posed here. Therefore it was decided to use individual interviews to facilitate the exploration of the research question.

Individual interviews are the most commonly used method within qualitative research (Gill et al., 2008) and allow researchers to explore personal context and accounts with individuals to a greater depth than focus groups. Interviews also allow a deeper understanding of what underpins and therefore drives an individual's health behaviour such as emotions, motivations and decisions (Ritchie & Lewis, 2013) by allowing subsequent questions to be influenced by the response of participants previous answers. Interviews can be classified into: structured; semi-structured or

unstructured. Unstructured interviews commonly start with an open ended question and progress without a predetermined structure or direction researchers wish the questioning to take. This method is particularly helpful when 'virtually nothing is known about the subject area' (Gill et al., 2008). However, this method is very time consuming and may yield a lot of data unrelated to the research question. In contrast, structured interviews almost act as verbal questionnaires. These may be beneficial when target populations have limited literacy or to improve compliance of answering, however, they are inflexible and do not allow researchers to explore data further than the next set questions allows. Therefore, semi-structured interviews sit somewhere in the middle of the two. Normally, they are informed by a topic guide, which acts as a 'documentation of subjects to investigate that serves as an interview agenda, guide, or aide memoire' (pg 115, Ritchie & Lewis, 2013) and allow flexibility in the topics and discussions with participants while retaining strategic structure and focus. Therefore, semi-structured one-to-one interviews were conducted to complete this research study.

4.3 Aim and objectives

The aim of this study was:

- To uncover the important components for tooth brushing behaviour, and to identify whether processes are automatically or cognitively driven.

Objectives of this study were:

1. To describe the nature of tooth brushing behaviour.
2. To describe what cues stimulate tooth brushing behaviour for adults.

3. To describe the potential or known motivators for regular tooth brushing for adults to encourage or maintain behaviour repetition.

4.4 Methods

4.4.1 Study design

4.4.1.1 Ethical approval

Ethical approval was obtained by the National Health Service (NHS) Research Ethics Committee (East of England -Essex), reference 15/EE/0053. NHS research governance approvals were obtained prior to commencing the study (Appendix 4).

4.4.1.2 Setting

Interviews took place in a single primary care centre (Moorgate Primary Care Centre, Bury) providing NHS urgent dental care in a deprived area of North West England (IMD score 57.29; 5th (most deprived) Quintile group). This centre has both a community dental service (which predominantly provides care for children and special needs patients) and a dental access service (for patients with a dental emergency, i.e. dental pain, dental trauma), treating over 150 patients per week. Due to the heterogeneous people mix initially proposed by the sample matrix, this centre was ideally positioned to recruit this type of sample. In addition, perhaps this setting is one where tooth brushing habits are less embedded, due to the high levels of deprivation (NHS Digital, 2013), and so represents a stringent test of the research question.

4.4.1.3 Inclusion / Exclusion criteria

a) Inclusion criteria:

Participants were required to brush their teeth at least once a day in order to allow the researcher to explore the nature of that behaviour. As a proxy to this, included individuals had to be dentate (i.e. have at least one tooth in their mouth). Both male and females participants were included.

b) Exclusion criteria:

Participants under the age of 18 were excluded. As documented in the systematic review chapter (Chapter 3), under the Children Act 1989 (Legislation, 2018), a child is defined as someone who has not yet reached their 18th birthday, although it is acknowledged that this age may vary dependant on different circumstances (e.g. legal age of consent). Therefore, the decision was made to set the age limit at 18 years or over. Individuals with mental and physical disabilities were also excluded. This exclusion was made because it was considered that their ability to develop habitual tooth brushing behaviour may be hindered by their reliance on other individuals to conduct their oral hygiene care.

4.4.1.4 Recruitment

Prompted by study publicity (i.e. information posters and leaflets about the interview were displayed in appropriate areas such as the reception counter of the dental service and on the walls of the waiting area) and by receptionists informing patients about the research as they signed in for their dental appointment, individuals identified themselves as willing to participate. These individuals were approached by the researcher and checked for their eligibility. For participants who met the criteria, the researcher gave further information (including the approved participant

information sheet) and answered any additional questions before the participant signed the consent form. Written informed consent was obtained from all participants prior to interviewing and participants were informed that they were free to terminate the interview or remove themselves from the study at any point without implications for their treatment.

4.4.1.5 Interviews

Twenty-nine semi-structured interviews, lasting up to 30 minutes were conducted by a single researcher (HR) using a topic guide. This topic guide was initially constructed to explore people's daily lives, the structure (or lack of) their days including changes in the weekend, dental experience (including their thoughts on the importance of oral health), and how tooth brushing behaviour was performed (Appendix 5). This guide remained flexible to allow for more focused questioning of emerging data. For example, after the initial few interviews, it appeared that tooth brushing may be habitual. Therefore, the guide structure changed to ensure the prompting of questions to underpin the behaviour more clearly such as the cues which initiate tooth brushing behaviour and the motivators to establish behaviour repetition.

All interviews were audio-taped and transcribed for analysis. Patient transcripts were anonymised using codes P1-P29. In addition, field notes were made during and after the interviews as memos to capture additional observational data and the interviewer's reflections from the interviews. They included information around the dynamic of the interview and on the body language of the interviewees. All interviews took place on the day of consent, in a designated area, set apart from any

surgeries or clinical areas. Participants were offered a cool off period and were offered to be interviewed in an environment comfortable and appropriate for both the participant and the researcher (i.e. participant's own home, local café). However, all participants were happy to be interviewed at the primary care centre. Participants were free to decline from being interviewed at any point and this was reiterated to all participants at the start of the interview.

4.4.1.6 Sample and sample size

Initially, purposive sampling was undertaken followed by theoretical sampling, allowing for the development of emerging theory (Coyne, 2008). Careful consideration was given to the emerging data which highlighted any alterations in sampling required and to identify appropriate numbers of participants. Number of participants interviewed was dependant on data and theoretical saturation (i.e. when theory was not perceived to be further developed by new data, (Mason 2010)).

Interviewees comprised a mixture of ages, gender, ethnicity, daily tooth brushing frequencies and SES status (see Table 1). SES of participants was determined by translating their home postcode into an Index of Multiple Deprivation (IMD) quintile (NPEU Tools, 2016) – the fifth quintile being the most deprived and also taking the NS-SEC (National Statistic Socio-Economic classification).

4.4.2 Analysis

The framework method of thematic analysis or qualitative content analysis was used to analyse the data (Gale et al., 2013; Braun & Clarke, 2006). Framework method has been used widely within health research (Heath et al., 2012; Gale & Sultan,

2013; Sheard et al., 2012) as it offers itself to researchers as an effective tool to manage and map interview data (Gale et al, 2013). It facilities the development of themes within the data and allows constant comparison of data within an interview and between other interviews. NVIVO was used to code the data with similar codes being grouped together into categories or themes (Braun & Clarke, 2006). The broad themes incorporated into the thematic analysis were based on the theoretical literature on habit formation theory; 'habit', 'cues' and 'motivators'. Each theme contained subthemes all related to the overarching theme (Table 4.2). An 'other' code was also included to allow for coding of important data that did not fit into the pre-determined codes. Data analysis took place alongside data collection, with emerging themes nested in subsequent interviews until a point of data saturation was reached, i.e. additional interview data did not add to the emerging theory. This was considered to have occurred after the conduct of the 23rd interview. The main data coder also conducted the interviews. To ensure rigour, in addition to the active analytic process, the researcher remained responsive (i.e. open and sensitive) to evolving data with emergent findings and analysis also tested with a wider analytic team (Morse et al., 2002). For example, coding was discussed at supervisory meetings to ensure agreement and to discuss the grouping of codes into categories. In addition, detailed discussion of the coding of transcripts and subsequent grouping together into categories or themes took place during the habit lab meetings under Professor Wendy Wood at the University of Southern California (USC), where a body of habit researchers meet to discuss current habitual research. The members of the habit lab offered expert opinions of the coding and grouping of data in relation to habit theory. This opportunity was facilitated by the ICAT short experience fellowship.

4.5 Results

Twenty-nine participants were interviewed at the dental access centre in Bury before data saturation was considered to be achieved. Table 4.1 gives an overview of the participant characteristics of included participants. Table 4.2 gives an overview of the broad themes, subthemes and the categories framework.

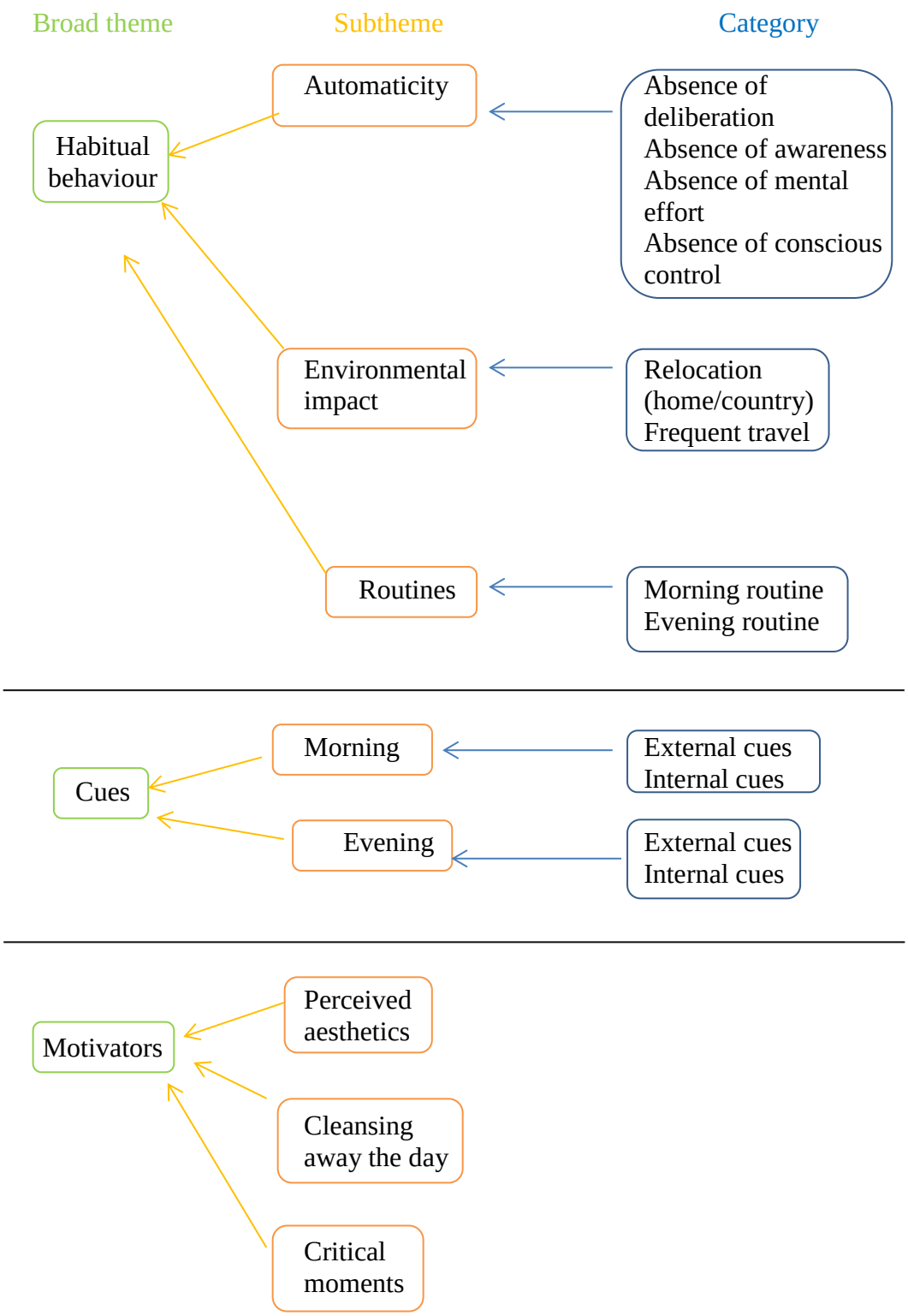
Table 4.1 Participant characteristics

Partic-ipants	Gender	Age	Ethnicity	Occupation	IMD Quin tile**	TB freq. (per day)	Pay for dental treat-ment***
P1	Female	77	White	Retired Child Care officer	5th	1/2	Yes
P2	Male	26	White	Factory worker	3rd	2	Yes
P3	Female	23	White	Copywriter	5th	2	Yes
P4	Male	68	White	Retired carpenter	2nd	1/2	Exempt
P5	Male	50	White	Legal counsel	2nd	2	Yes
P6	Male	50	Mixed ethnic groups	Manual Labour	3rd	3	Yes
P7	Male	60	White	Manual Labour	5th	1	Yes
P8	Male	29	White	Works within a finance company	4th	2	Yes
P9	Female	28	White	Support worker	5th	2	Exempt
P10	Male	36	White	Technical support	5th	2	Yes
P11	Female	37	White	Teacher	3rd	2	Exempt
P12	Female	20	White	Works in a chippy	5th	2	Exempt
P13	Female	28	White	Teaching assistant	5th	2	Exempt
P14	Male	47	White	Professional	4th	1	Yes
P15	Female	24	White	Un-employed	4th	1	Exempt
P16	Female	23	White	Works at First Bus Depot	5th	2	Yes
P17	Male	31	Asian	Factory worker	4th	3	Yes
P18	Male	28	White	Un-employed	3rd	2	Exempt
P19	Male	21	White	Un-employed	5th	1	Exempt
P20	Male	58	White	Carer	5th	2	Exempt
P21	Male	83	White	Retired	5th	1	Exempt
P22	Female	30	Asian	Media support	5th	2	Yes
P23	Female	35	White	Care assistant	4th	2	Yes
P24	Female	59	White	Un-employed	3rd	2	Exempt
P25	Male	37	White	Charity worker	4th	2	Yes
P26	Male	25	White	Electrician	3rd	2	Yes
P27	Male	19	White	Student	5th	2	Yes
P28	Female	27	White	Nursery worker	5th	2	Yes
P29	Female	67	White	Retired	3rd	2	Yes

*Quintile based on postcode of home address

**Under NHS regulations certain categories such as pregnant women, un-employed and low-income individuals are exempt from patient co-payment for treatment.

Table 4.2 Overview of themes, subthemes and categories framework



The next section of the results described the three main broad themes which emerged from the data; nature of tooth brushing behaviour, cues and motivators, with example quotations from the transcripts for each. Extracts from the transcripts are indicated by quotation marks with ellipses (. . .) indicating omitted speech. Brackets [ ] indicate text entered by myself to aid interpretation. All quotations are identified to the participant's unique ID number (P1-P29).

4.5.1 The nature of tooth brushing behaviour

Overwhelmingly, tooth brushing behaviour appears to be conducted in a habitual manner. Participants, unprompted, even classify the behaviour as habitual. For example,

> *'...I've just got into ... mmm ... I've gotten into the habit it to [brushing in the morning] ...' (P2, Male)*
>
> and
>
> *'It's a habit and if you break that habit. You don't want to break that habit…' (P9, Female)*

4.5.1.1 Automaticity

Data however identified that rather than just purely a routinised behaviour which participants described as a 'habit', they identified all four characteristics of automaticity as associated with tooth brushing behaviour and so automaticity populated a category within the analytical framework. This category was made up of four codes, one for each of the distinct features of automaticity: 1) absence of deliberation; 2) absence of awareness; 3) absence of mental effort and 4) absence of

conscious control. Figure 4.1 shows example quotations from the transcripts coded under each of the four characteristics of automaticity.

Figure 4.1 Example quotations from transcripts for the four characteristics of automaticity

Code	Transcript example
Absence of deliberation	*'No, it not like mmmm yeah I think I'll brush my teeth now, you know, it's just something that happens ...' (P23, Female)*
Absence of awareness	*'...you know sometimes I'm not even aware that I've started to brush my teeth ...' (P28, Female)*
Absence of mental effort	***I*** ***Okay, and then you finish watching TV and go and*** *R* *Well I don't think, "Oh, I've got to brush my teeth". (P18, Male)*
Absence of conscious control	***I*** ***Okay. And do you have a reminder, to remind you to do it or…?*** *R* *No, I just do it. (P1, Female)*

4.5.1.2 Routines

However, significant individual variation in habitual tooth brushing behaviour was evident, as was a distinction between morning and evening tooth brushing behaviour. The most frequently reported tooth brushing behaviour was in the morning. Only two participants reported not brushing their teeth (either regularly or irregularly) at this time (P7 & P15). Morning brushing was consistently described by participants, as strongly integrated into their well established, daily cleansing routines, such as showering or face washing. This remained true even when time pressures, such as 'sleeping-in' became a factor.

> *'…I'll always brush even if I've hit the snooze button one too many times…it makes me uncomfortable if I don't' (P26, Male)*

Interestingly, when time of day was reversed (as in night shift routines), links between showering and tooth brushing before leaving for work were still observed.

'Right so that's the same every single day. So I will get up, I will go in the shower, I will have a shower erm I do the teeth, go downstairs, get changed, …' (P18, Male)

4.5.1.3 Environmental impact

Habitual behaviour was also demonstrated by evidence that the sequence of events had pre-eminence over the environment in which they were carried out. For example, morning and evening habitual tooth brushing appeared to be unaffected when travelling away for work or moving countries, where individual routines remained constant.

'Yeah if I am working away and staying in a hotel, it's the same routine when I am away yeah'. (P8, Male)

And

INT ***And have you always done it like that [brush after showering]?***

R *Yes, yes always.*

INT ***Even when you changed country?***

R *Yes, yes.* *(P2, Male)*

4.5.2 Cues (stimuli) to morning and evening tooth brushing

According to habit theory, once behaviour has become habitual; cues initiate the enactment of behaviour (Gardner, 2015). As discussed within the literature review chapter (section 2.2.2), cues may be time, event or activity based (Stawarz, Cox & Blandford, 2014; McDaniel & Einstein, 2007) and occur externally (outside the

individual's body) or internally (inside the individual's body). This section will discuss what 'cues' tooth brushing behaviour in the morning and the evening.

4.5.2.1 Morning cues

The data showed that morning brushing was initiated predominantly in response to external cues, such as visual cues i.e. seeing the toothbrush in the bathroom whilst washing the face; or preceding actions i.e. showering prior to brushing the teeth.

> *'…Yeah cause if they are there [in the bathroom], my toothbrush and toothpaste are there so if I keep them there then I will [brush]…' (P12, Female)*

This quotation is an example of event-based cue, as seeing the object (tooth brush and toothpaste) in the stable environment (bathroom) laid to the initiation of the tooth brushing behaviour (Einstein & McDaniel, 1990).

> *'Errr…I get out of bed and go and have a wash and brush my teeth, erm…do my hair get ready, go downstairs let the animals out erm…have a coffee, have breakfast and then set off to work, go and get the bus.' (P17, Male)*

Whereas, this is an example of activity-based cues as tooth brushing behaviour is initiated at the end of a predetermined activity (having a wash in this example).

4.5.2.2 Evening cues

Evening tooth brushing habits were relatively variable, sometimes reported as a result of inconsistencies in the sequence and context of participants evening

activities. A mixture of cues were identified as initiating evening brushing and included both external and internal cues. Internal cues or strong feelings (urges) were described as initiating the tooth brushing behaviour to the extent, on occasion, of even being able to hinder a person's ability to sleep until brushing was completed. Such urges are characteristic of behaviour which is automatically driven (Kelly & Barker, 2016).

> *'As I said, I feel it's quite natural for me now in the morning…it wasn't at night, but it's become part of my night routine, and I'm not comfortable… I will get into bed and I won't be comfortable…. You know, so if I don't do that I just don't feel right… silly… it's not, you know, it's not dramatic or anything it's just my silly way of my brain saying to me you must clean your teeth, you know.' (P4, Male)*

External cues also initiated evening tooth brushing behaviour. For example, taking off make-up was an external activity based cue which initiated tooth brushing behaviour for one interviewee.

> *'So, yeah, I'll do whatever I need to do, then take my make-up off, brush my teeth, get changed …' (P22, Female)*

4.5.3 Motivators for tooth brushing behaviour repetition

Three main motivator subthemes were identified (Table 4.2) and include; 1) perceived aesthetics; 2) cleansing away the day and 3) critical moments. Tooth brushing motivators were found to vary between participants, with differences between morning and evening behaviour. Evening tooth brushing motivators appeared to be more idiosyncratic.

4.5.3.1 Perceived aesthetics

A common morning motivator identified the perceived aesthetic benefits related to social acceptability. Participants reported wanting to make themselves presentable to others at the start of their day.

> *'I try to because when you start work the first thing is people look at your outer skin, your oral health and stuff like that, especially when you are engaging with people you have got to do all this.' (P11, Female)*

4.5.3.2 Cleansing away the day

One important motivator, especially important for individuals from the manual and routine occupation category of NS-SEC (Office of National Statistics, 2010) , was that by cleaning their teeth, participants felt able to remove the contaminants from the day (such as smoking and unhealthy eating) and restore their mouth to a fresh, unspoiled state.

> *'Well I love the feeling of just like having a clean mouth after a long day after eating all my junk food and whatever it's just nice to feel and the taste of them, I like the taste of them knowing its fresh' (P16, Female)*

The 'cleansing' motivator was described as not only a physical, but a psychological cleansing. 'Cleansing' the mouth following a hard manual working day, was sometimes a motivator to brush at an additional, third time in the day (once home from work). Interestingly, this additional tooth brushing behaviour was still strongly linked to bodily cleansing, and cued by taking a shower or having a bath.

> *'Just to be clean and know that I have got the day gone out of my mouth…' (P14, Male)*

4.5.3.3 Critical moments

Critical moments also emerged as an important motivator. Twice daily tooth brushing was rarely reported to have been established and subsequently maintained from childhood. Instead, interviewees reported changing their tooth brushing behaviour due to a critical moment or experience in adulthood which challenged the level of importance they placed on (and their motivation towards) brushing twice daily.

> *'And then when my front tooth went, like the side one I thought go to the dentist and then obviously I thought if they are working with me I have to work with them [start brushing twice daily]….'(P13, Female)*

While increase in tooth brushing frequency was found to be predominantly the result of these critical moments which were initially effortfully performed, over time there were signs that the behaviour had become automatically initiated. Critical moments or events for participants included experiencing visible anterior dental decay (where previous posterior decay did not initiate behavioural change), experience of dental pain / toothache, dental extraction and realisation of the importance of retaining dentition in later life.

> *'With my teeth being how they were and alarm bells are ringing now I am nearly 30 years old I need to start caring for my teeth a bit more'. (P9, Female)*

> *'I think I started when I started getting my first toothache, cause it was really painful. I thought if I start brushing it might help and obviously help my*

other teeth because it's horrible, it's not something I like going through so I started brushing my teeth.' (P25, Male)

'...having like serious problems like that [dental pain] it makes you want to look after your (P3, Female)

INT Yeah, so what point changed you, can you remember the moment where you thought really I need to try and brush more regularly?

R I just started getting bad teeth all the time, do you know like bad teeth all the time, do you know like fillings here, filling there. (P24, Female)

4.6 Discussion

It is important to understand the nature of morning and evening tooth brushing behaviours in order to effectively design future interventions. In summary, tooth brushing behaviour appears to be automatically performed in individuals who brush regularly. Indeed, tooth brushing (principally morning) behaviour is predominantly integrated into personal daily sequences of behaviour, cued by a number of different salient stimuli. It appears to be most consistently performed when it is conducted within an individual's pre-existing daily routine. Finding tooth brushing as a routinised behaviour is consistent with the theoretical model proposed by Aunger (2007), and may help to mediate the development of habitual behaviour (see literature review chapter, section 2.8.4)

Tooth brushing in the evening was found to be relatively less habitual, probably because of the non-routinised nature of evening times, which can obstruct the

development of a strongly routinised evening brushing routine and result in a lack of consistent tooth brushing prior to bed. This mirrors a recent study into children's tooth brushing behaviours, mentioned previously within the literature review (section 2.2.4), where the lack of an evening routine was found to be related to poor brushing behaviours (Trubey, Moore, Chestnutt, 2014). This study however is the first to identify that a similar pattern appears to be present in adults. Future habitual interventions should therefore aim to focus on establishing a stable evening routine prior to bed and include tooth brushing within this sequence of events, if possible. Alternatively, tooth brushing could be attached to an already stable evening behaviour. For example, finishing the evening meal might be identified as an appropriate external cue to brush, and habitual brushing established around the end of the meal. This approach would require caution and future exploration to ensure that the efficacy of brushing was not affected by other activities such as snacking on cariogenic foods or drinks after brushing. In addition, findings within this study support the importance of identifying a unique, individualised, pertinent activity within an individual's daily routine to become an effective cue to establishing a tooth brushing habit.

Motivators for behaviour repetition are important to habit establishment (Lally et al., 2010), although these can diminish over time without impacting upon habitual behaviour since action (e.g. brushing) eventually becomes automatically initiated by cues without conscious processing (Rothman, Sheeran, Wood, 2009). Whilst one could argue that oral health education motivates individuals, literature repeatedly shows that such interventions translate into only a small and unsustained positive change (Kay & Locker, 1996; see literature review chapter, section 2.7). Findings

from this study suggest that motivating components of future interventions should include a more personalised, non-scientific reason for tooth brushing, which may be particularly useful when developing interventions for low SES groups. Examples may include psychological as well as physical cleansing from the burdens of the day. There is good evidence, from outside dentistry, that mouth washing actually results in psychological benefits for individuals because it is effective as a moral cleansing activity (Lee & Schwarz 2011a, Lee & Schwarz 2011b). This may provide a potentially powerful way in which tooth brushing might be promoted in populations who place a low value on having good oral health. This study is the first study on oral health behaviour in adults to identify this having important implications for intervention approaches.

Although there is a lot of evidence for childhood tooth brushing being an important motivator for maintaining the behaviour into adult life (Lissau, Hoist & Friis-Hasché, 1990), there was little evidence for this in our data. One reason for this may have been the selective nature of our sample. On the other hand, this may also have been due to parental prompts (reminders) being the predominant cue for children's tooth brushing behaviour rather than a child's own individualised salient cue (Gill et al., 2011). Once the parental reminder (cue) is removed, habitual tooth brushing behaviour is no longer initiated and results in lapsed tooth brushing behaviour in adult life. This supports previous evidence from a school intervention, which demonstrated that once the external cue was removed (i.e. participants left school, toothbrush or toothpaste supply removed), habitual tooth brushing behaviour diminished (Wind et al., 2005).

It is therefore important that future interventions which establish habitual tooth brushing behaviour rely on the identification and consideration of individual, salient cues to action initiation. For some adults, the restoration of twice daily tooth brushing behaviour required a critical moment to act. These events challenged their view of their current oral hygiene practices. Behaviour change was initially reported as cognitively effortful, with individuals having to consciously remember to brush their teeth twice a day. However, over time, the behaviour began to occur automatically without the thoughtful effort initially required. This is in line with the habit formation of other behaviours such as weight loss (Lally, Wardle & Gardner, 2011).

4.6.1 Limitations

It is necessary at this point to acknowledge a few study limitations. Data collection was limited to one dental centre, and participants attending for urgent care. This may limit the generalisability to the wider population. However, since this is a qualitative study with the purpose of generating hypotheses (Golafshani, 2003), and the first study of its kind, it provides some important and new evidence about the elements which underpin tooth brushing behaviour. Recruitment was deliberately focussed in a dental access centre so that this would lead to the inclusion of a range of people who had irregular oral health behaviours (dental visiting) and were likely to have other irregular behaviour with respect to tooth brushing too (NHS Digital, 2013).

4.7 Conclusion

This study helps understand the nature of tooth brushing behaviour which appears, when established, to be performed in a habitual manner. However, there is a need, perhaps, to start to consider tooth brushing behaviour in the morning separately from the evening when designing future habitual interventions. Due to the distinct differences in cues to initiate behaviour and motivators to drive the behaviour repetition identified within this piece of work, future design of interventions would require tailoring to the specific target behaviour. The important components would be to identify and consider salient cues to initiate tooth brushing and ensure appropriate motivators for behaviour repetition are considered.

Chapter 5: Cross-sectional survey to explore the automaticity of oral hygiene behaviours

5.1 Overview and rationale for the study

Having explored in depth, via qualitative methods (Chapter 4, Study 2), tooth brushing behaviour and identified its habitual nature, i.e. performed automatically without cognitive effort, this posed further questions to address, such as, how generalisable is habitual tooth brushing behaviour across a wider population? Is tooth brushing always more habitual in the morning compared to the evening? What are some of the key individual characteristics which may influence the level of automaticity able to be achieved for tooth brushing behaviour?

In order to address some of these questions, the next piece of work involved conducting a cross-sectional survey to explore the automaticity of oral hygiene behaviours. As well as tooth brushing behaviour, this study also explored questions around the habitual nature of flossing, as previous intervention work suggests that this behaviour too can become habitual (Judah, Gardner & Aunger, 2013; Orbell & Verplanken, 2010). Indeed the limited interventional work to date has focused on delivering a habitual flossing intervention (see literature review chapter, section 2.8.7.1).

In addition to automaticity, oral hygiene behaviour could also be examined as comprising both behaviour instigation and behaviour execution – to take account of a discrete difference between 'deciding' (behavioural instigation or intention) and 'doing' (behaviour execution or action) a particular behaviour. Either, both or none

of these subcomponents (behaviour instigation or execution) may be automatically primed. It is important to distinguish which, if any, of the oral hygiene behaviour subcomponents are conducted in a habitual (automatic) manner, since emerging evidence suggests that habit instigation may be more important than habitual behaviour execution for long term maintenance of frequent behaviours (Phillips & Gardner, 2016).

As well as exploring how generalisable habitual tooth brushing and interdental cleaning are to the population, further exploration was aimed towards understanding the associations between certain participant characteristics and levels of automaticity. As the literature review chapter highlighted, participant characteristics can influence habits. For example, intention and goal strength may have less influence as habit strength increases (Ouellette & Wood, 1998; De Bruijn & Rhodes, 2011; De Bruijn et al, 2007; Wood & Neal, 2007), due to the automatic nature of habitual behaviour. Participant personality and personal routine preference may also influence habit development –more conscientious and highly routinised individuals can develop faster and stronger habits due to the repetition of 'cued' behaviour in a consistent environment. Motivation, self-control and self-efficacy may also play an important part initially in establishing behaviour, although once established, habits can persist even after motivation, self-control and self-efficacy diminish (Lally, Wardle & Gardner, 2011). It is therefore important to identify the association, if any, of a range of participant characteristics with oral hygiene behaviours found to have habitual features, in order to inform future interventions.

The rest of this chapter reports the cross-sectional survey undertaken. The rationale for conducting a cross-sectional study is presented followed by the aim, methodology and results. Finally, within the discussion section, limitations of the study are noted alongside further recommendations for practice and future research.

5.2 Cross-sectional survey

Cross-sectional surveys are classified as an observational study. They record, in a snapshot, the level of health, disease or behaviour in a given population at a set time (Sedgwick, 2014) and are often used and best suited for understanding the prevalence of a behaviour or disease within a well-defined population (Mann, 2003). In addition to this, cross-sectional surveys are also advantageous due to the relatively easy and quick administration, the elimination of a loss to follow-up, and the ability to use information gathered to explore associations between one measured outcome against another. However, cross-sectional surveys do not support arguments of causation and this is their main limitation (Sedgwick, 2014).

5.3 Aim

The aim of this study was:

- To add empirical evidence to the theoretically hypothesised habitual nature of oral hygiene behaviours by exploring self-reported levels of oral hygiene behaviour automaticity in adults using the SRBAI.
- To investigate whether the behaviours were either instigated and/or executed in a habitual way.

- To investigate any association of individual characteristics (such as participant personality and personal routine preference) with self-reported behavioural automaticity.
- To help inform future developments of behavioural intervention to improve the oral hygiene behaviours of adults which may benefit from taking a habitual approach.

5.4 Hypotheses

1: Morning tooth brushing behaviour will have statistically significant higher self-reported automaticity scores than evening tooth brushing behaviour.

2: Tooth brushing instigation will have statistically significant higher self-reported automaticity scores that tooth brushing execution.

3: Interdental cleaning instigation will have statistically significant higher self-reported automaticity scores than interdental cleaning execution.

4: Self-reported automaticity levels for both tooth brushing and interdental cleaning will be influenced by participant characteristics and the socio-economic status (SES) gradient.

In addition, participant personalities have been shown to influence levels of habitual behaviour in order behaviours, such as smoking (Malouff, Thorsteinsson & Schutte, 2006).

5.5 Methods

5.5.1 Study design

5.5.1.1 Ethical approval

Ethical approval was obtained by the National Health Service (NHS) Research Ethics Committee (South Central – Oxford C), reference: 16/SC/0142. NHS research governance approvals were also obtained prior to commencing (Appendix 6).

5.5.1.2 Setting

The survey was conducted in a range of NHS dental service providers in the North of England. This included a dental access centre (providing emergency dental care only); a dental hospital (a secondary care centre, providing emergency dental care); and three NHS general dental practices (providing a mixture of emergency and routine dental care). One dental practice from a high, medium and low socio-economic (SES) area was chosen, where SES was based on the postcode of the dental practice, and categorised according to the Index of Multiple Deprivation quintile (NPEU Tools, 2016). This study aimed to explore the generalisability of tooth brushing automaticity and so recruiting participants from a range of dental care providers allowed for a purposive sample to be achieved, i.e. we wanted to recruit individuals with a range of tooth brushing behaviours (from low to higher frequency of the behaviour which may or may not have been associated with varying levels of automaticity).

5.5.1.3 Recruitment

All patients who reported to the reception desk at the dental service providers were invited by the researcher to take part in the survey. The study aim and participant

involvement within the study was discussed with all patients before allowing them time to assess whether or not they wished to participate. Informed consent was obtained from all participants prior to commencing after ensuring each participant was suitable for inclusion. Thirty participants were recruited from each of the dental practices, thirty participants from the dental access centre and thirty participants from the dental hospital. Participants self-completed a questionnaire, delivered through the 'Qualtrics' platform (an online data management resource) on an iPad device, whilst waiting for their dental appointment. On occasions when the internet was limited, the researcher completed the questionnaire with the participants using a paper form of the questionnaire. Each participant was allocated a unique participant ID number to ensure confidentiality, which was maintained throughout the study.

5.5.1.4 Procedure

An initial pilot survey was undertaken with seven participants from each of the three different types of dental service providers. The purpose of the pilot was to assess and refine questionnaire readability and reliability and so adjustments to the questionnaire were made according to the outcome of this pilot work. For example, confusion arose around the meaning or understanding of the terms 'behavioural instigation and execution'. This resulted in rephrasing of the question to clarify what each term meant.

5.5.2 Inclusion / Exclusion criteria

a) Inclusion criteria:

Adults aged 18 years or older. Again this cut off point for adults was decided upon based on the legal age of an adult (Legislation, 2018). Participants were required to

be dentate (i.e. participant who have at least one tooth remaining in their mouth) as consideration to the cleansing of dental appliances (such as dentures) was out of the scope of this piece of work. Individuals were also expected to have the capacity to give their own informed consent and be able to independently conduct oral self-care practice. This is important when considering the formation of habitual behaviour as behaviour conduct rests solely on one self rather than a carer, for example.

b) Exclusion criteria:

Participants were excluded if they were judged to not adequately understand spoken and/or written English. Unfortunately, there were insufficient resources to translate the study measures into different languages.

5.5.3 Measures

5.5.3.1 Demographic measures

Demographic information on age, gender, ethnicity and SES status was gathered. Age and gender were asked as open ended questions to allow participants to choose their own response. Ethnicity measurement was taken using the GSS harmonised standards on ethnic group (Office of National Statistics, 2015) and consists of five groups (White; mixed or multiple ethnic groups; Asian or Asian British; Black or African or Caribbean or Black British; Other). SES status was measured using occupation (Office of National Statistics, 2010) and level of education based on highest level of educational qualification (Connelly, Gayle & Lambert, 2016; Schneider, 2010). Due to the lack of one single, best measure of SES status, two common measures were included in order to achieve as accurate a measurement of SES as possible (Galobardes et al., 2006).

5.5.3.2 Oral hygiene frequency measures

Information about frequency of tooth brushing and interdental cleaning behaviour was also collected in line with the Adult Dental Health Survey (Office of National Statistics, 2012). Five different frequency options (twice (or more) a day; once a day; once a month; less than once a month; never) were presented to the participant as well as an 'other' option.

5.5.3.3 Automaticity measures

Self-Reported Behavioural Automaticity Index (SRBAI) was used to measure the automaticity of tooth brushing (morning and evening) and interdental cleaning instigation and execution, by making appropriate adjustments to the question stem. As discussed within the literature review chapter (section 2.8.3), the SRBAI has been found to be a reliable, sensitive and efficient scale to measure automaticity (Gardner et al, 2012). Figure 5.1 shows an example of the measure for initiation of morning tooth brushing.

Figure 5.1 Example of SRBAI question for initiation of morning tooth brushing

Deciding to brush your teeth in the MORNING is something ...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
... I do automatically	❍	❍	❍	❍	❍
... I do without having to consciously remember	❍	❍	❍	❍	❍
... I do without thinking	❍	❍	❍	❍	❍
... I do before I realise I'm doing it	❍	❍	❍	❍	❍

Responses are measure on a five-point Likert Scale (1= strongly disagree, 5 = strongly agree). The overall SRBAI score therefore ranged from four to twenty, with higher scores meaning higher levels of behaviour automaticity. However, on reflection, this question should also have included the option to report 'not

applicable' to avoid participants from selecting neither agree nor disagree if they do not perform the behaviour (Gardner & Tang, 2014). This issue was resolved by ensuring the removal of any answers which were not applicable, i.e. if a participant reported brushing only once daily in the morning, SRBAI scores for the evening were excluded from analysis.

5.5.3.4 Participant characteristic measures

Participant personality was measured using the validated brief Big 5 personality measure (Rammstedt & John, 2007; Gosling, Rentfrow & Swann, 2003). On a 5-point Likert Scale (1 = disagree strongly, 5 = agree strongly), participants reported how strongly they felt ten set statements (reflecting five constructs for personality - extraversion, agreeableness, conscientiousness, neuroticism (emotional stability) and openness to experiences) reflected their own personality. Of these ten statements, five were reverse scored. Each construct had a score between two and ten, with higher score meaning higher levels of extraversion, agreeableness, conscientiousness, neuroticism (emotional stability) and openness to experiences. Participant personality was measured as previous studies have demonstrated their effect on habitual behaviour (Roberts et al., 2009; Wood, Quinn & Kashy, 2002).

Routine preference was measured using the Personal Need for Structure scale (Neuberg & Newsom, 1993). This consisted of twelve items which explored participant's attitudes, beliefs and experiences around a number of different scenarios. For example, on a 6-point Likert Scale (1 = strongly disagree, 6 = strongly agree), participants were asked questions like 'I'm not bothered by things that interrupt my daily routine; I don't like situations that are uncertain; I hate to be with

people who are unpredictable'. Four reverse scored items were included within the scale, giving scores between twelve and seventy-two. Higher scores meant a higher personal need for structure. Measuring routine preference was conducted because individuals with high personal need for structure and, therefore, highly routinised lives, more consistently repeat behaviour in stable contexts, and this stable repetition aids behavioural automaticity development (the active ingredient of habit behaviour) (Gardner, 2012; Lally et al., 2010; Wood, Quinn & Kashy, 2002).

Self-control was measured using the brief self-control scale (Tangney, Baumeister & Boone, 2004). This consisted of thirteen items, measured on a 5-point Likert Scale (1 = not at all, 6 = very much), centred around how participants perceive themselves. Questions included 'I am good at resisting temptation; I wish I had more self-discipline'. Nine reverse items were included within the scale, giving scores between thirteen and sixty-five. Higher scores meant higher levels of self-control. Measuring self-control was conducted because high levels of self-control encourage behaviour discipline and promote behaviour repetition and subsequent habit formation (Duckworth & Gross, 2014; McGowan et al., 2013; Lally et al., 2010).

Self-efficacy was measured, using a 10-point Likert scale ranging from 0 = cannot do it at all to 10 = highly certain can do it, by asking the question: 'How confident are you that you will brush your teeth?' (Bandura, 2006). Higher scores indicated higher levels of self-efficacy. Intention was also measured (Ajzen, 2006) using a 7-point Likert scale (1=Very unlikely to 7 = very likely). Participants were asked to select the most appropriate response to the statement: 'I intend to brush my teeth for the next 3 months'. Higher scores indicated higher levels of intention.

5.5.4 Sample size calculation

In order to power the study preliminary data would be needed on the spread of automaticity for the behaviours studied. As no such data currently exists, there was insufficient information available in order to inform a meaningful sample size calculation. An arbitrary sample size of 150 participants was therefore set, and was anticipated to be adequate based on similar exploratory studies of this nature. For example, Lally et al (2010) recruited 96 participants to investigate the habit formation process for simple behaviours.

It is anticipated that this study would serve as a pilot study, and the pilot data collected would allow for a more accurate determination of future sample size calculations, including the standard deviation of automaticity of the oral hygiene behaviours studied (tooth brushing and interdental cleaning).

5.5.5 Statistical analysis

Statistical analysis was carried out using SPSS v 22.0. A p value of less than 0.05 was considered significant. Cronbach's alpha was used to measure scale reliability (Tavakol & Dennick, 2011; Gleim & Gleim, 2003; Santos, 1999). For continuous variables, data was expressed as median and interquartile range (IQR) whereas numbers and percentages were used for categorical variables. Due to the skewed data, the non-parametric Wilcoxon signed rank test was used to compare SRBAI scores. Multiple regression analyses were performed to identify any association between SRBAI and SES / participant characteristics.

5.6 Results

Participation rate was 100% with 150 participants completing the survey. Forty-eight people refused to participate due to: 1) lack of time (37, 77.1%); 2) did not want to participate when approached (9, 18.8%) or 3) did not meet inclusion criteria (2, 4.2%). Baseline demographic and oral health behaviours of participants are summarised in Table 5.1.

Table 5.1 Participant characteristics

	Category	No. of participants	% of participants
Gender	Male	83	55.3
	Female	67	44.7
Age	Mean 42.8 years Median 41 years Range 18-82 years		
Ethnicity	White	134	89.3
	Mixed or multiple ethnic groups	2	1.3
	Asian or Asian British	9	6.0
	Black or African or Caribbean or Black British	4	2.7
	Other	1	0.7
SES Occupation*	Class 1	33	22.0
	Class 2	37	24.7
	Class 3	38	25.3
	Class 4	42	28.0
SES Education **	1-4 O levels / CSEs / GCSEs (any grade), Entry Level, Foundation Diploma	7	4.7
	NVQ Level 1, Foundation GNVQ, Basic Skills	1	0.7
	5+ O levels (oases) / CSEs (grade 1) / GCSEs (grades A*-C), School Certificate, 1 A-Level / 2-3 AS levels, VSEs, Higher Diploma	25	16.7
	NVQ Level 2, Intermediate GNVQ, City and Guilds Craft, BTEC First / General Diploma, RSA Diploma	12	8.0
	Apprenticeship	4	2.7
	2+ A Levels / VCEs, 4+ AS Levels, Higher School Certificate, Progression/Advanced Diploma	18	12.0
	NVQ Level 3, Advance GNVQ, City and Guilds Advance Craft, ONC, OND, BTEC National, RSA Advanced Diploma	15	10.0
	Degree (for example BA, BSc), Higher Diploma, BTEC Higher Level	32	21.3
	Professional qualifications (for example teaching, nursing, accountancy)	21	14.0
	Other vocational / work-relation qualifications	4	2.7
	Foreign qualifications	4	2.7
	No qualifications	7	4.7

*Measured using occupation (Office of National Statistics, 2010)
** Measured using highest education qualification (Schneider, 2010)

	Category	No. of participants	% of participants
Tooth brushing frequency	Twice (or more) a day	124	82.5
	Once a day	23	15.4
	Morning	19	12.7
	Evening	4	2.7
	Once a month	1	0.7
	Less than once a month	1	0.7
	Other	1	0.7

Interdental cleaning frequency	Twice (or more) a day	15	10.0
	Once a day	30	20.0
	Once a month	6	4.0
	Less than once a month	1	0.7
	Never	78	52.0
	Other	20	13.3

The Cronbach's alpha for each behaviour or characteristic is tabulated into Table 5.2, and suggests there is a high internal consistency for each scale.

Table 5.2 Cronbach's alpha for scales used

Behaviour / Characteristic	Cronbach's alpha
Tooth brushing	
Morning instigation	0.91
Morning execution	0.83
Evening instigation	0.96
Evening execution	0.89
Interdental cleaning	
Instigation	0.90
Execution	0.89
Participant personality*	
Extraversion	0.52
Agreeableness	0.48
Conscientiousness	0.58
Neuroticism (emotional stability)	0.65
Openness to experiences	0.39
Personal need for structure	0.79
Brief self-control scale	0.72

* These scores are in keeping with the original study (Gosling, Rentfrow & Swann, 2003), which has high test-retest reliability.

The sample comprised mostly of individuals of White ethnicity (134, 89.3%) and males (83, 55.3%). An even spread across the SES gradient was achieved, reflecting recruitment from a range of types of dental services. There was also a balanced

mixture of ‘emergency’ dental visiting compared to ‘regular’ dental visiting. Self-reported behavioural automaticity index (SRBAI) score was reported for tooth brushing and interdental cleaning behaviour, instigation and execution (Figure 5.2 & 5.3). As expected, more participants reported brushing twice daily (124, 82.7%), although this is higher than previously reported for dental surveys, e.g. Adult Dental Health Survey, United Kingdom (Office for National Statistics, 2012), where 75% of adults reported brushing their teeth at least twice a day.

Results show that established tooth brushing behaviour is performed habitually. For example, with morning instigation SRBAI scores, 80 (55.6%) participants reported maximum automaticity scores of 20, increasing to 90 (62.5%) participants for execution. A further 35 (24.3%) participants for morning instigation and 27 (18.8%) participants reported their score between the 17-19 range (Figure 5.2). Established interdental cleaning (including flossing) SRBAI scores appears more variable and less automatic than tooth brushing. For example, only 11 (15.3%) participants reported the full automaticity score of 20 for instigation and 16 (22.2%) participants reporting full automaticity scores for execution (Figure 5.3).

Figure 5.2 Tooth brushing self-reported behavioural automaticity index (SRBAI) spread

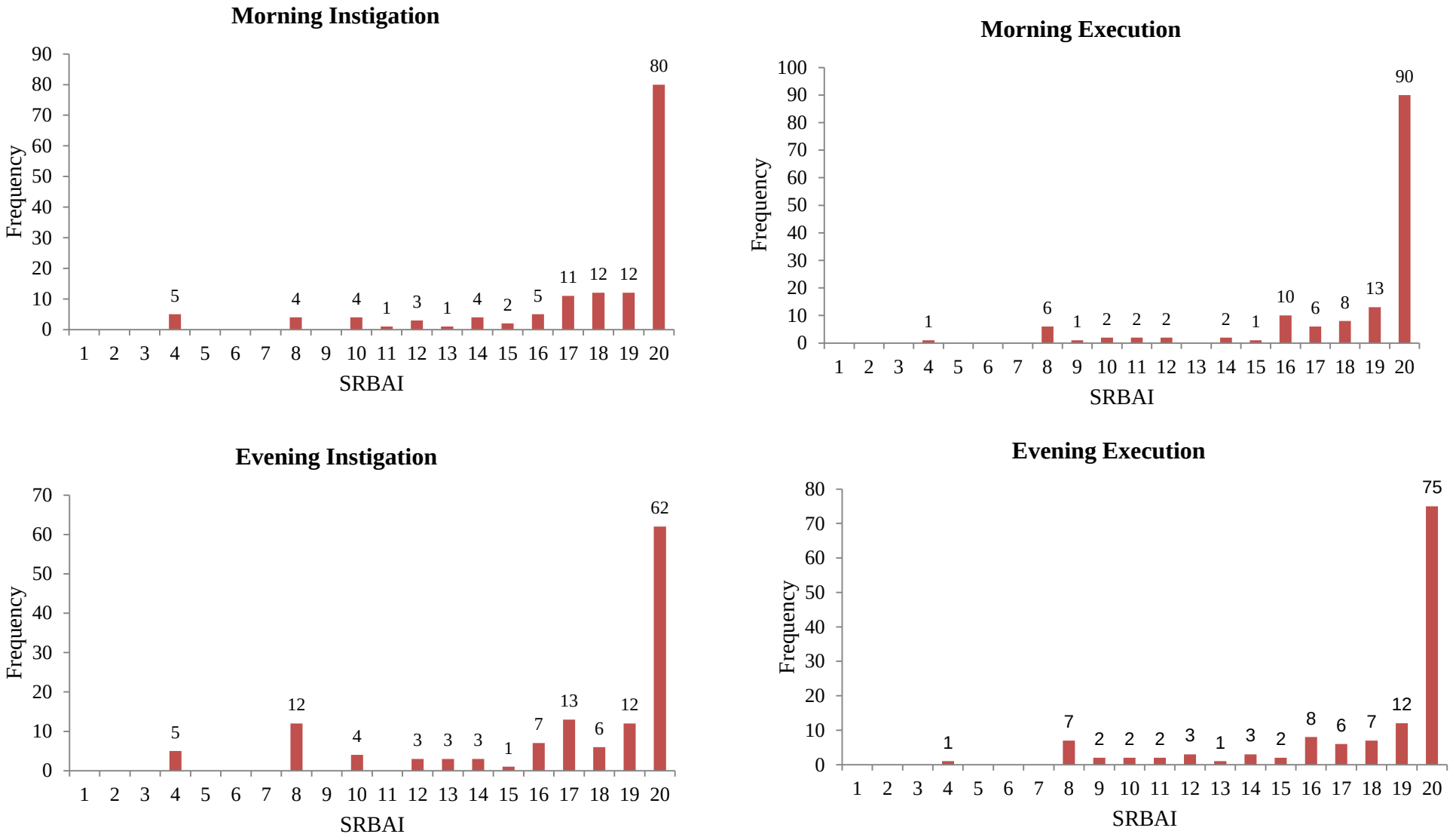
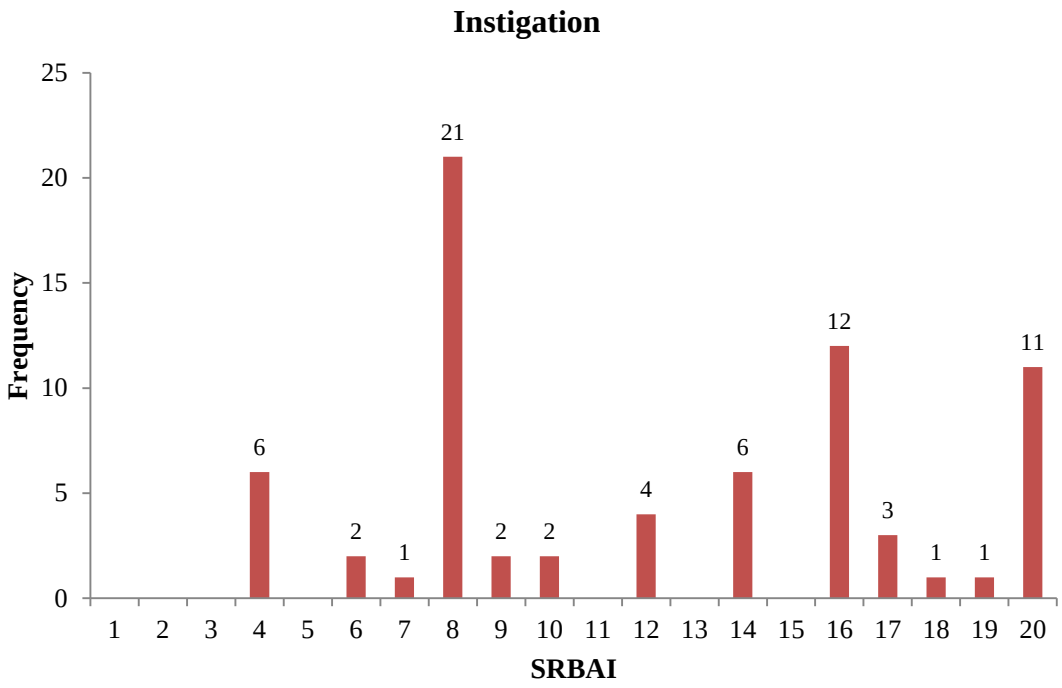
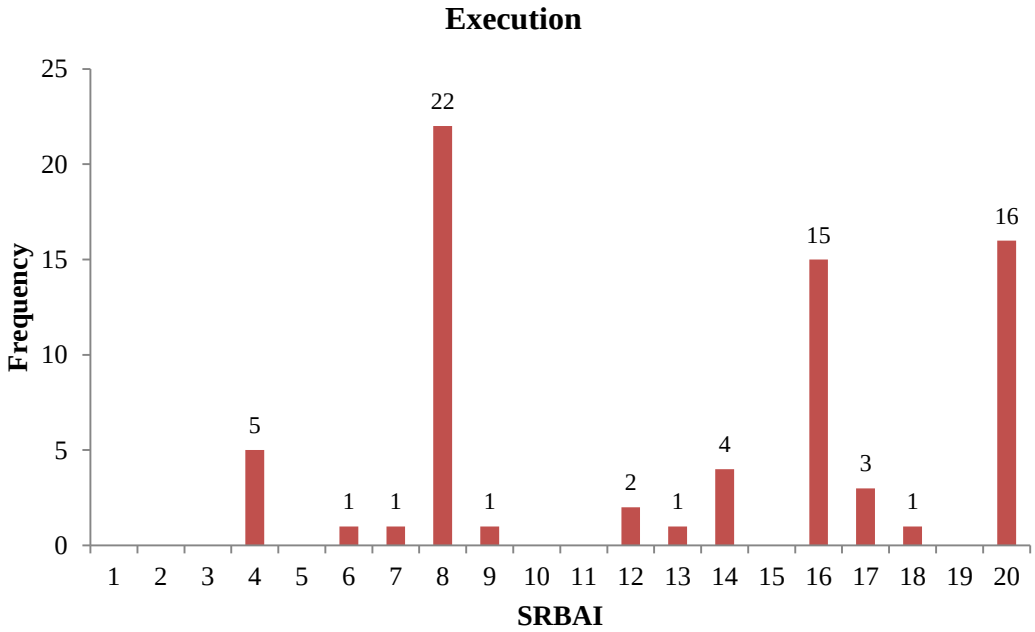


Figure 5.3 Interdental cleaning self-reported behavioural automaticity index (SRBAI) spread





5.6.1 Hypothesis 1

For individuals who brush twice daily (n=124), SRBAI scores were statistically significantly higher in the morning (Median = 19.50, Interquartile Range 2.38) than in the evening (Mdn = 19.00, IQR 4.0), Z=-3.315, p=0.001). The Wilcoxon signed rank test (Table 5.3) showed 94 (75.8%) participants had equal morning and evening SRBAI scores, 24 (19.4%) participants had a higher SRBAI score for the morning than evening and 6 (4.8%) participants reported a lower SRBAI score for morning than evening. Therefore, hypothesis 1 was accepted.

Table 5.3 Wilcoxon signed rank test results for hypothesis 1

	N	**Mean Rank**
Evening tooth brushing < Morning tooth brushing	24	16.40
Evening tooth brushing > Morning tooth brushing	6	11.92
Evening tooth brushing = morning tooth brushing	94	
Total	124	

p=0.001

5.6.2 Hypotheses 2 & 3

Tooth brushing SRBAI instigation score (Mdn = 20.0, IQR 3.0) and execution SRBAI scores (Mdn = 20.0, IQR 3.0) were statistically significantly different, Z=-2.601, p=0.009, with execution scores being higher. The Wilcoxon signed rank test (Table 5.4) showed 137 (49.8%) participants had equal instigation and execution SRBAI scores. 58 (21.1%) participants had higher instigation scores than execution, and 80 (29.1%) participants had higher execution scores than instigation. This was mirrored in interdental cleaning scores where interdental cleaning instigation SRABI scores (Mdn = 14.0, IQR 8.0) were statistically significantly higher than interdental

cleaning execution SRBAI scores (Mdn = 16.0, IQR 9.0), Z=-2.256. p=0.024. Again, the Wilcoxon signed rank test (Table 3) showed 47 (65.3%) participants had equal instigation and execution SRBAI scores. 8 (11.1%) participants had higher instigation scores than execution, and 17 (23.6%) participants had higher execution scores than instigation. Therefore both hypothesis 2 & 3 were accepted.

Table 5.4 Wilcoxon signed rank test results for hypothesis 2 & 3

Wilcoxon signed rank test results for hypothesis 2

	N	**Mean Rank**
Evening tooth brushing < Morning tooth brushing	58	61.65
Evening tooth brushing > Morning tooth brushing	80	75.19
Evening tooth brushing = morning tooth brushing	137	
Total	275	

p=0.001

Wilcoxon signed rank test results for hypothesis 3

	N	**Mean Rank**
Execution of interdental cleaning < instigation of interdental cleaning	8	9.88
Execution of interdental cleaning > instigation of interdental cleaning	17	14.47
Execution of interdental cleaning = instigation of interdental cleaning	47	
Total	72	

p=0.00

5.6.3 Hypothesis 4

Tables 5.5 & 5.6 demonstrates the results from the multiple regression analysis which explored the association of SES and participant characteristics on SRBAI scores for both tooth brushing behaviour (Table 5.5) and interdental cleaning (Table 5.6).

5.6.3.1. Tooth brushing

Table 5.5 shows the multiple linear regression model of predictors of self-reported automaticity index (SRBAI) for tooth brushing. Intention to tooth brush was removed from the model due to multicollinearity with motivation. Adjusted R^2 = 0.197 with R^2 = 0.273. Therefore, the linear regression explained 27.3% of variance in the data. The Durbin-Watson value = 2.147. It was therefore assumed there was no first order linear auto-correlation. In addition, the F-test was highly significant (0.000) suggesting the model explained a significant amount of variance in SRBAI tooth brushing scores. Analysis showed age, gender, self-efficacy and an agreeableness personality all significantly predicted higher automaticity scores for tooth brushing behaviour. However, these scores remained constant across the SES gradient.

Table 5.5 Multiple linear model of predictors of self-reported automaticity index (SRBAI) tooth brushing scores

Model	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
Motivation	.012	.011	1.056	0.293
Age	.035	.016	2.195	0.030*
SES (Occupation)	.022	.117	.193	0.848
SES (Education)	-.356	.535	-.665	0.507
Gender	1.346	.516	2.610	0.010*
Ethnicity	.368	.319	1.153	0.251
Self-Efficacy	.046	.016	2.830	0.005*
Routine preference	-.040	.025	-1.600	0.112
Personality (Extraversion)	-.033	.110	-.298	0.766
Personality (Agreeableness)	.243	.104	2.341	0.021*
Personality (Conscientiousness)	.169	.152	1.107	0.270
Personality (Neuroticism)	.004	.105	.037	0.971
Personality (Openness)	.193	.126	1.526	0.129
Self-Control	-.052	.031	-1.670	0.097

a. Dependent Variable: Tooth brushing self-reported behavioural automaticity index scores
*p < 0.05

5.6.3.2 Interdental cleaning

Table 5.6 shows the multiple linear regression model of predictors of self-reported automaticity index (SRBAI) for interdental cleaning. Adjusted $R^2 = 0.517$ with $R^2 = 0.625$. Therefore, the linear regression explained 62.5% of variance in the data. The Durbin-Watson value = 1.90. It was therefore assumed there was no first order linear auto-correlation. In addition, the F-test was highly significant (0.000) suggesting the model explained a significant amount of variance in SRBAI interdental scores. Intention to interdental clean significantly predicted higher automaticity scores for this behaviour.

Interestingly, SES was also shown to significantly predict higher automaticity scores for interdental cleaning. Indeed, lower SES individuals appear to have significantly higher automaticity score for interdental cleaning than individuals in higher SES, based on occupation. Perhaps one reason for this result may lie within the higher levels of individual motivation to interdental clean, which results in more consistent repetitions of interdental cleaning within a stable environment, resulting in higher automaticity scores. In contrast, individuals from higher SES may conduct interdental cleaning on a more inconsistent pattern, resulting in lower self-reported automaticity levels. However, this explanation would require further investigation.

Table 5.6 Multiple linear model of predictors of self-reported behavioural automaticity index (SRBAI) interdental cleaning scores

Model		Unstandardized Coefficients		t	Sig.
		B	Std. Error		
	Motivation	.043	.024	1.820	0.075
	Intention	1.654	.433	3.815	0.000*
	Age	.050	.032	1.597	0.116
	SES (Occupation)	-.553	.226	-2.446	0.018*
	SES (Education)	-.446	1.020	-.438	0.664
	Gender	-1.338	1.116	-1.199	0.236
	Ethnicity	.718	.528	1.360	0.180
	Self-Efficacy	-.006	.026	-.239	0.812
	Routine preference	.027	.057	.473	0.638
	Personality (Extraversion)	-.335	.233	-1.435	0.157
	Personality (Agreeableness)	-.012	.207	-.060	0.953
	Personality (Conscientiousness)	-.410	.322	-1.273	0.209
	Personality (Neuroticism)	.064	.202	.316	0.754
	Personality (Openness)	.200	.273	.733	0.467
	Self-Control	.050	.064	.770	0.445

a. Dependent Variable: Interdental cleaning self-reported behavioural automaticity index scores
*p < 0.05

5.7 Discussion

This cross-sectional survey reported automaticity measures of oral hygiene behaviour in adults to explore whether these behaviours were instigated and/or executed in habitual ways. The study also examined a selection of different participant characteristics such as participant personality and personal routine preference to begin to uncover how these variables may be associated with self-reported automaticity for oral hygiene behaviours. It is anticipated that this information will help inform future developments of behavioural intervention to improve the oral hygiene behaviours of adults which may benefit from taking a habitual approach.

5.7.1 Tooth brushing

Established tooth brushing behaviour appears to be performed habitually. For example, high tooth brushing SRBAI scores of 17-20 for morning tooth brushing instigation reported by 115 (79.9%) participants confirms this and suggest that when behaviour is established, it is performed in an automatic manner. However, it was noted that automaticity scores for morning tooth brushing were statistically higher than evening tooth brushing. This suggests that perhaps evening tooth brushing behaviour is more variably performed. In keeping with the qualitative study (Study 2, Chapter 4), variance in evening routines result in missed opportunities to brush their teeth. Although occasional lapses (missing one day but performing the behaviour before and after the omission) in behaviour has been shown to not significantly hinder habit formation (Lally et al, 2010), other studies have shown that longer lapses in behaviour do negatively affect future conduct of behaviour (Armitage, 2005).

Tooth brushing instigation ('*deciding*') automaticity scores were statistically higher than execution ('*doing*'). This is advantageous in relation to tooth brushing as it suggests that individuals automatically decide to perform the behaviour but exert more cognitive effect over how they brush. Considering how they perform their tooth brushing may lead to a more thorough conduct. However, the true clinical effect of this statistical significance requires further exploration.

Interestingly, age and gender were significantly associated with automaticity scores for tooth brushing behaviour. Older participants and females were demonstrated to have higher levels of automaticity. Perhaps higher levels of engagement in health

behaviours for woman than men (Thompson et al., 2016; Ek, 2015; Umberson, 1992), results in more consistent, repeated behaviour performance which subsequently develops a stronger habitual tooth brushing behaviour.

Self-efficacy was demonstrated to be significantly associated with higher automaticity scores for tooth brushing behaviour. This is an important consideration for future interventions which aim to establish twice daily tooth brushing, as it is suggested that such interventions should contain a component which addresses individual self-efficacy towards brushing their teeth, to encourage habitual tooth brushing.

Motivation was not significantly associated with higher SRBAI tooth brushing scores. This is in keeping with the habit formation literature, which suggests that in order to establish habitual behaviour, individuals must have sufficient motivation to perform the desired behaviour repetitively until it becomes automatic (Lally & Gardner, 2013; Gardner, Lally & Wardle, 2012). However, once habitual behaviour is established, behaviour may continue even when motivation for such behaviour wanes (Neal et al, 2011).

5.7.2 Interdental cleaning

Interdental cleaning (including flossing) is more variable in the self-report of automaticity levels and appears to be less automatic than tooth brushing. For example, only 15.3% of participants reported full automaticity scores for instigation of interdental cleaning compared to 55.6% for instigation of tooth brushing behaviour. One possible explanation of this may be because execution of flossing

behaviour requires cognitive input, perhaps even with the aid of external cues (for example a mirror, which allow participants to place the floss into the correct position). This contrasts to tooth brushing behaviour which may be more easily performed without the need for external aids. Intention to perform interdental cleaning influenced the self-reported automaticity scores, with those who had stronger intentions reporting higher automaticity scores. When considering future interventions to establish interdental cleaning, an important component of the intervention should focus on ensuring that the individual has an intention to clean interdentally. This was a finding consistent with habit formation theory which states the first step to establishing habitual behaviour is having the intention to perform the behaviour (Lally & Gardner, 2013; Gardner, Lally & Wardle, 2012).

5.7.3 SES and oral hygiene automaticity levels

Socio-economic status (SES) was not predictive of automaticity scores for tooth brushing behaviour. This suggests an equally effective habit formation supporting tooth brushing behaviours across the socio-economic spectrum. This is important when considering interventions to address the inequalities in oral health, i.e. engaging individuals with lower SES backgrounds, who are reported to have poorer oral health compared to higher SES (Watt & Sheiham, 1999), to form habitual tooth brushing to improve their oral health status. Future interventions which aim to establish habitual tooth brushing should therefore be effective across the SES spectrum. This is advantageous as universally effective interventions ensure that widening of inequalities in oral health does not result, due to disproportionately benefiting those who live in lower socio-economic status.

However, socio-economic status was predictive of automaticity scores for interdental cleaning behaviours, but only when the measure of occupation rather than education was used.

5.7.4 Limitations

We found a higher prevalence of twice-daily tooth-brushers (82.7%) within our participant group than in a previous national study of adults in the United Kingdom (75% reported twice-daily tooth-brushing), (Office of National Statistics, 2010). It may reflect our recruitment methods involving adults attending the dentist rather than, for example, at home (although recruiting in part from an urgent dental care setting was intended in part to offset this). However, because data was collected in a dental setting, this may have heightened response bias among participants who may have been aware of recommended routines related to oral hygiene and expected levels of self-care. Alternatively, the higher prevalence of reported tooth brushing frequency might have been a result of a sample bias.

5.8 Conclusion

In conclusion, this study adds empirical evidence to the habitual nature of oral hygiene behaviours – suggesting that both morning and evening tooth brushing behaviours are instigated and executed in a habitual manner. There is still some query over the automaticity of interdental cleaning behaviour which requires further exploration. Tooth brushing automaticity levels appear to be associated with age, gender and self-efficacy whilst interdental cleaning is associated with intention to perform behaviour.

Chapter 6: Tooth brushing intervention development in vulnerable populations

6.1 Overview

Chapter 4 (qualitative study to identify the nature of tooth brushing behaviour) and Chapter 5 (cross-sectional survey to explore the automaticity of oral hygiene behaviours) demonstrated the habitual nature of tooth brushing behaviour. However, this posed further questions to address; could this theory be applied to develop a habitual tooth brushing intervention? What should the intervention include? What are the important components to the intervention from a participant perspective?

6.2 Study structure

This study aims to explore how habitual tooth brushing intervention could be delivered to vulnerable populations. The first consideration, which is reported as Study A, was on the application of a habitual tooth brushing intervention to individuals who may be likely to be vulnerable to oral disease (e.g. dental caries and periodontal disease) due to their unstable or variable routines. Particularly, this study focused on whether an identifiable cue to initiate tooth brushing behaviour could be determined, and in addition, how acceptable the developed intervention was for individuals with such fluctuating daily life patterns.

In contrast, Study B, explores how this type of intervention might be delivered within a health setting for a vulnerable population. Consideration was given to the development for use among a variety of different population groups but pregnant women was decided upon based on a number of different reasons including 1) pregnant woman are at an increased risk of periodontal disease and dental caries

(Farland et al., 2015; Murphey & Fowles, 2010; Rakchanok et al., 2010; Laine, 2009; Silk et al., 2008); 2) benefits may relate not only to the pregnant woman but also to the unborn child as well (Puertas et al., 2017; Perunovic et al., 2016; Vamos et al., 2015; Boggess and Edelstein, 2006) and 3) pregnancy represents a significant life stage event and a 'teachable moment' when women may be particularly open to adopt healthier behaviour (Olander et al., 2016; NICE, 2014; Phelan, 2010).

6.3 Study A

6.3.1 Overview

Chapter 4 concluded that the three important aspects of habitual tooth brushing are; cues, motivators and routines.

a) Cues

As also discussed within the literature review chapter (section 2.2.2), a key component to establishing habitual behaviour is context-dependent repetition of behaviour, linked to a particular cue to a desired behaviour (Gardner, 2015; Stawarz, Cox & Blandford, 2014; Einstein & McDaniel, 1990; Kvavilashvili et al., 1996). The identification of the salient, individualised cue is pertinent to the initiation of the tooth brushing behaviour and subsequently to the establishment of a tooth brushing habit. Therefore, identification of an individual's cue was considered as one of the key component of the intervention.

In addition to the identification of the cue, literature shows that forming an Implementation Intention (II) may help facilitate the mental linking of the chosen, individualised cue to tooth brushing behaviour (Webb & Sheeran, 2007; Gollwitzer

& Sheeran, 2006; Webb & Sheeran, 2008; Gollwitzer, 1999). In particular, IIs are effective at delegating the control of tooth brushing to foreseeable cues. They involve encoding the form 'If I encounter x cue, I will do y behaviour' and have been shown to have a small to medium effect size on physical activity (Bélanger-Gravel et al., 2013) and a strong effect on eating a healthy diet (Adriaanse et al., 2011). It was anticipated, that by incorporating an II component within the intervention, this would serve as an effective tool to help participants to establish habitual twice daily tooth brushing behaviour.

b) Motivators

Motivators for behaviour repetition are important to establish habitual behaviours, and indeed, are an important determinant for behavioural change (Michie, Atkins & West, 2014; Weidemann et al., 2014; Gardner & Lally, 2013). Chapter 4 discussed the differences between morning and evening tooth brushing motivators. For example, morning motivations included aesthetic benefits of brushing whereas evening motivations were more focused on removing the remnants of the day. Therefore, identification of an individualised motivator to perform twice daily tooth brushing behaviour formed another key component to the intervention (if the participant wasn't already motivated to brush twice daily).

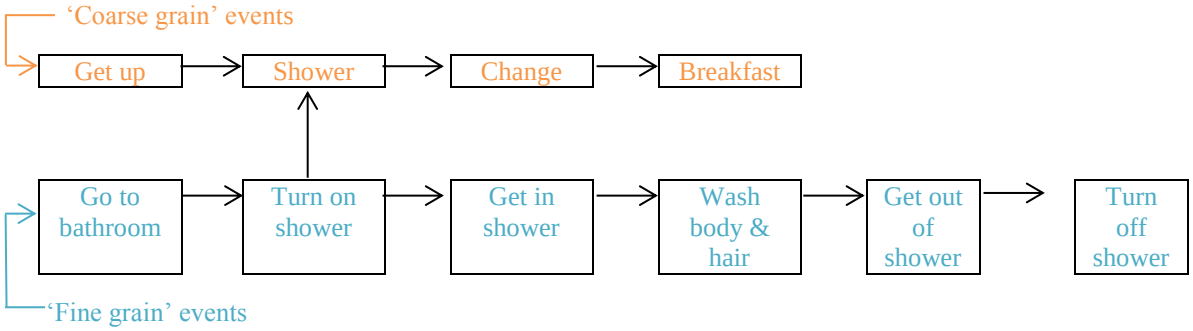
c) Routines

Again, Chapter 4 discussed morning tooth brushing behaviour being successfully integrated into an individual's routine. Indeed, successful integration of a new action into a pre-existing daily routine will help to establish habitual behaviour, as it will

increase the chances of an individual constantly repeating the behaviour (Lally, Warde & Gardner, 2011; Judah, Gardner & Aunger, 2013; Aunger, 2007).

Event Segmentation Theory (EST) argues that routines can be reliably organised into 'coarse grain' (less detailed) events and 'fine grain' (more detailed) event (Zacks & Swallow, 2007; Zacks & Tversky, 2001). For example, getting ready for work in the morning may be broken down into coarse and fine grain events (Figure 6.1). In addition to this, 'large task' boundary points exist between coarse events, and have been suggested as suboptimal points to insert the new behaviour (Lally, 2013; Aunger, 2007). Indeed, in a study by Judah et al. (2013), which explored the psychological determinants of a habitual flossing intervention, showed that implementing a new behaviour at an event boundary was significantly less successful at producing a flossing habit, than placing it within the 'fine grain' events. Therefore, this study will aim to 'cue' the new tooth brushing behaviour within the 'fine grain' events of an individuals established routine.

Figure 6.1 Coarse and fine grain events for getting ready for work in the morning



6.3.2 Study A aim and objectives

The aim of this study was:

- To develop and explore the concept, delivery, and timings of a one-to-one tooth brushing intervention based on habit formation theory targeted towards achieving twice daily tooth brushing in adults.

The objectives of this study were:

- To explore with one-to-one interviews the acceptability and potential effectiveness of the intervention
- To identify problems with recruitment and utility of the eligibility screening questions
- To assess likely consent rates, reasons for non-consenting, and any possible barriers and facilitators to study recruitment
- To identify the approximate length of intervention delivery

6.3.3 Proposed intervention

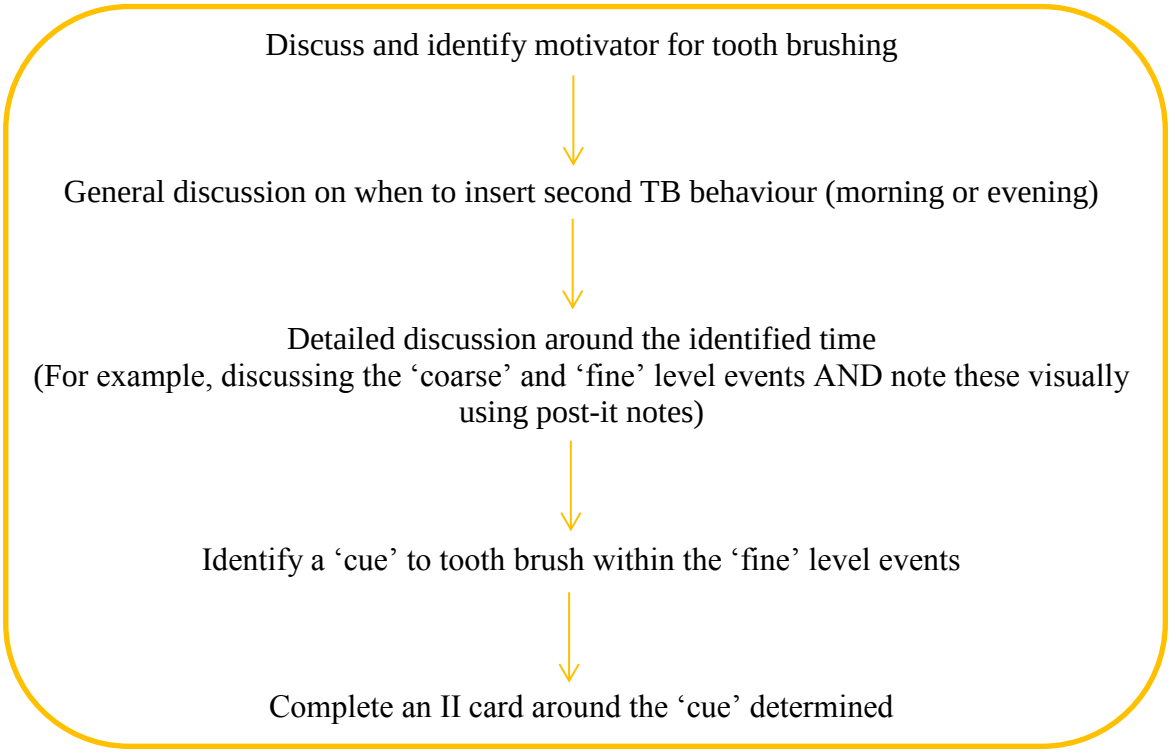
The proposed intervention (Figure 6.2) is based upon components of an intervention delivered to students and the general public to encourage the development of habitual flossing behaviour (Judah, Gardner & Aunger, 2013) and includes all the important components considered in the overview section (6.1) of this chapter. In addition, the intervention also included a co-design process, as participants were involved in the construct of the intervention (see Figure 6.2).

A previous habit theory study aimed at increasing flossing behaviour has been undertaken with participants from the general public and a student population (Judah,

Gardner & Aunger, 2013). This described a sequence of components which have been identified as important in the overview section (6.3.1) of this chapter and so the same framework was adapted for application to tooth brushing behaviour in this study (Figure 6.2).

In addition, this co-design method of engaging participants in discussion around their coarse and fine grain events to identify cues to initiate behaviour helps in the description and translation process of how this research could be implemented into general practice (Nilsen, 2015). Indeed a recent narrative review of theories, models and frameworks which guide implementation science, has suggested that "describing and/or guiding the process of translating research into practice" is one of the three key aims of implementation science and important in ensuring evidence-based practice (EBP) in healthcare (Nilsen, 2015).

Figure 6.2 Proposed intervention to establish habitual tooth brushing



6.3.4 Methods

6.3.4.1 Study design

6.3.4.1.1 Ethical approval

Ethical approval was obtained by Health and Life Sciences Research Ethics Committee (Psychology, Health and Society) at the University of Liverpool, reference 4022 (Appendix 7).

6.3.4.1.2 Sample and sample size

This intervention development study aimed to recruit adult members of the public who have flexible or unstable routines. Individuals with flexible routines were chosen to explore if these individuals have some established coarse and fine level events to attach tooth brushing behaviour. Taking a purposive sampling strategy, the researcher made contact with organisations which would have contact with people such as those working within the hospitality industry.

Initially, a purposive sample was taken, based on people who had occupations such as shift work which might make establishing regular routines a challenge, but this progressed to a snowballing sample as other interviewees suggested other participants to be recruited. As this was a preliminary exploratory study on intervention development, the aim was to recruit 5-15 adults (aged over 18 years) who self-report as brushing once daily. The number included was based on previous intervention studies for habit formation (Lally, Wardle & Gardner, 2011).

6.3.4.1.3 Recruitment

Potential participants were approached in their public place of work (i.e. multiple coffee shops) and screened by verbal conversation for eligibility. If eligible, consent documents were issued, discussed and signed by both the participant and the researcher. A recruitment log was kept to record basic characteristics of those declining study participation and any reasons given. Contact details for the research team, including a study telephone number, were provided to participants. All participants were reimbursed with a £20 retail voucher for their time.

6.3.4.1.4 Intervention exploration

The following flowchart lays out how the tooth brushing intervention was explored:

1. Participants completed a short questionnaire (in paper form). This asked information about their demographic characteristics such as age, socio-economic status (SES) (measured by postcode & education) and ethnicity. It also asked participants about their tooth brushing frequency and self-report behavioural automaticity index (SRBAI) score for morning and evening tooth brushing (instigation and execution). Motivation, intention and self-efficacy to brush their teeth were also recorded. Please see section 5.4.3 in chapter 5 for justification on the measures used.

2. Discussion started around their current tooth brushing behaviours and identification of when to consider brushing for a second time.

3. Participants discussed, whilst the researcher formulated post-it notes around their coarse and fine grain level events around the best time to insert the new tooth brushing behaviour.

↓

4. Within the fine grain level detail, a constant preceding action was identified to which tooth brushing behaviour was attached.

↓

5. Participant then form an II following discussion with the researcher.

↓

6. The researcher then discussed the intervention with the participant to take feedback on their experience, in terms of delivery, potential effectiveness, issues etc.

↓

7. Once the participant has left the confidential environment, the researcher documented the individual's routinised behaviour (by photographing the post-it note activity) and recorded the cue to initiate tooth brushing.

As the overarching aim of this study was to explore this type of intervention with members of the public, detailed field notes of participant's interactions with the intervention were kept, paying particular attention to participants attitudes towards the intervention, timings, concept and content feasibility.

6.3.4.1.5 Confidentiality

Each participant was allocated a unique patient ID number which was noted against personal patient information (i.e. name, age, contact number etc.) in a confidential data form, and separately stored from all other information (in a lockable cabinet in a

different researcher's office). Home address was gathered to post reimbursement vouchers and was destroyed after issuing the vouchers.

6.3.4.1.6 Inclusion / exclusion criteria

a) Inclusion criteria:

Adults aged 18+ years who have the capacity to give their own informed consent and are able to independently brush their teeth, at least once a day.

b) Exclusion criteria:

Participants for whom a stable contextual environment is not possible, e.g. homeless, as habitual behaviour can only be established when the context remains stable (McGowan et al., 2013; Lally et al., 2010; Wood, Quinn & Kashby, 2002; Ouellette & Wood, 1998); vulnerable adults; individuals who do not adequately understand spoken and written English as unfortunately there were insufficient funds for translation and individuals who brushed their teeth twice daily or more.

6.3.4.2 Analysis

All interviews were audio-taped and transcribed for analysis. Field notes were taken as appropriate after the interviews, and immediately transcribed to ensure reliable reconstruction of the interview. Data analysis of the interviews was undertaken using the framework method of thematic analysis (Gale et al., 2013; Braun & Clarke, 2006) (see section 4.4.1.7 for justification).

6.3.5 Results

A total number of 29 potential participants were approached to participate. Twenty (68.9%) were unable to participate as they reported to consistently brushing twice daily. Therefore, a total of nine (31.1%) participants were eligible and took part in this exploratory study.

6.3.5.1 Participant characteristics

Due to the nature of the research being exploratory, the proportion of participants' responses in each of the categories for the measures collected is reported to give context to the qualitative reporting of participant's responses to the intervention being trialled and developed. They also provide some pilot data to inform setting up of qualitative measurements involved in a later feasibility stage which would test a more fully developed intervention (Eldridge et al., 2016).

Participant characteristics are summarised in Table 6.1. Four males (44.5%) and five females (55.5%) were recruited. Participants were predominantly White (8, 88.8%) and from a low SES area (based on home postcode) as six (66.7%) lived in the 5th quintile (most deprived). As predicted (based on the results from the qualitative study and the cross-sectional survey) more participants brushed only in the morning (7, 77.8%) compared to only in the evening (2, 22.2%).

Table 6.1 Participant Characteristics

	Category	No. of participants	% of participants
Gender	Male	4	44.5
	Female	5	55.5
Age	Mean 28.2 years Median 25 years Range 20-36 years		
Ethnicity	White	8	88.8
	Asian or Asian British	1	11.2
SES Postcode*	2nd quintile	1	11.1
	3rd quintile	2	22.2
	5th quintile	6	66.7
SES Education ****	5+ O levels (oases) / CSEs (grade 1) / GCSEs (grades A*-C), School Certificate, 1 A-Level / 2-3 AS levels, VSEs, Higher Diploma	2	22.2
	2+ A Levels / VCEs, 4+ AS Levels, Higher School Certificate, Progression/Advanced Diploma	4	44.4
	Degree (for example BA, BSc), Higher Diploma, BTEC Higher Level	2	22.2
	Professional qualifications (for example teaching, nursing, accountancy)	1	11.1
Tooth brushing frequency	Once a day	9	100.0
	Morning	7	77.8
	Evening	2	22.2

*Measured by translating home postcode into IMD quintile (NPEU, Tools, 2016)
** Measured using highest education qualification (Schneider, 2010)

The SRBAI scores (Table 6.2) for morning and evening tooth brushing behaviour (instigation and execution) show high automaticity levels for both instigation and execution where tooth brushing behaviour is already established (i.e. in their once a day conduct). For example, once daily morning tooth brushers had a median SRBAI score for instigation of 20.0 (IQR 1.0) and a median execution score of 19.0 (IQR 5.0). This is in keeping with habit theory which suggests that automaticity is the active ingredient and a marker of habitual behaviour (Gardner, 2012; Lally et al., 2010). Interestingly, automaticity levels for tooth brushing execution remained high even when tooth brushing behaviour was not regularly conducted. For example,

morning tooth brushers median evening execution SRBAI score was19.0 (IQR 4.0) whereas instigation scores were much lower at 6.0 (IQR 5.0), suggesting that this behaviour was still conducted in an automatic manner even if not initiated in this way. Seven participants (77%) reported being motivated to brush teeth twice daily. For those individuals (2, 22.2%) who were motivated only a little, the researcher explored with them other factors (as well as oral health benefits) which could help motivate the participant to brush. Field notes reported their low motivation resulted from lack of current dental problems (i.e. need for fillings at check-ups or dental pain). The researcher encouraged them around the long term benefits of tooth brushing and on the feeling of cleansing away the day. This seemed to be appreciated by one of the participants. Again, seven (77.7%) participants had an intention to brush twice daily and all but one participant reported high levels of self-efficacy relating to brushing their teeth.

Table 6.2 Participant variables

a) Self-reported behavioural automaticity scores (Once a day morning tooth brushers)

Participants	P1	P3	P4	P5	P7	P8	P9
Instigation Morning	20	18	20	20	19	19	20
Execution Morning	20	14	20	15	19	17	19
Instigation Evening	5	8	9	5	8	5	6
Execution Evening	20	14	19	15	19	17	19

b) Self-reported behavioural automaticity scores (Once a day evening tooth brushers)

Participants	P2	P6
Instigation Morning	8	5
Execution Morning	17	16
Instigation Evening	19	18
Execution Evening	16	16

c) Motivation

	Number of participants	Percentage of participants (%)
Not motivation at all	0	0
Motivated a little	2	22.2
Somewhat motivated	3	33.3
Motivated	3	33.3
Highly motivated	1	11.1

d) Intention

	Number of participants	Percentage of participants (%)
Very unlikely	0	0
Unlikely	1	11.1
Somewhat unlikely	1	11.1
Undecided	0	0
Somewhat likely	4	44.4
Likely	2	22.2
Very Likely	1	11.1

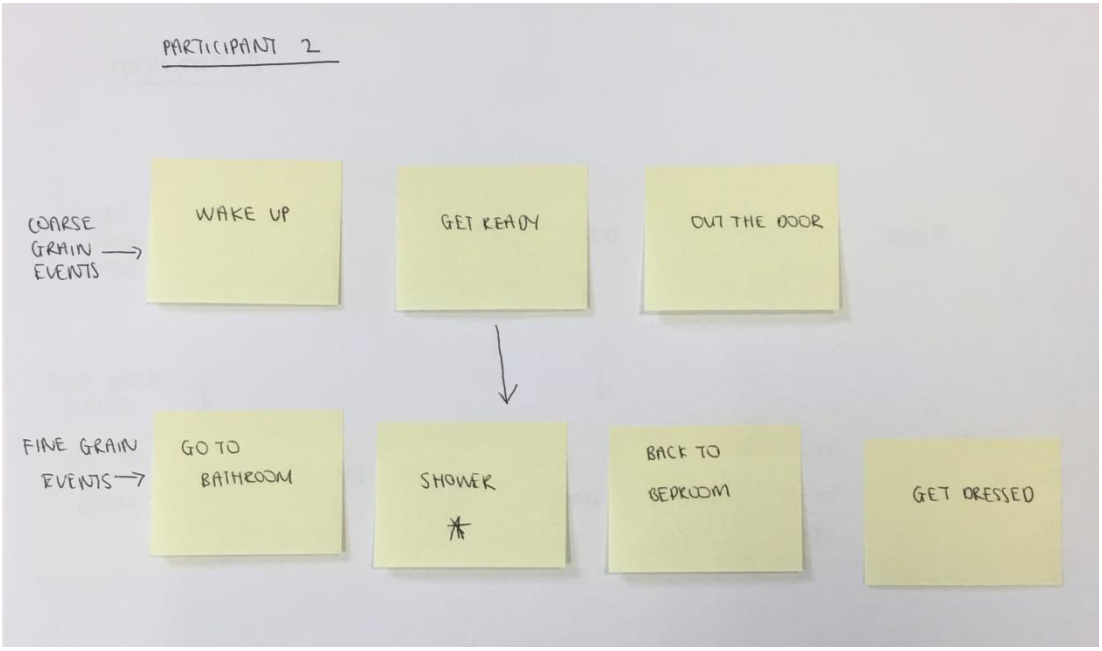
e) Self-efficacy

	Number of participants	Percentage of participants (%)
Cannot do it at all	0	0
Can do a little	1	11.1
Moderately can do	0	0
Certain can do	5	55.5
Highly certain can do	3	33.3

6.3.5.2 Description of routines

This section contains examples of the description of individual's routines with photographs of the post-it note intervention. For example Picture 6.1, reports participant 2 coarse and fine grain events. Having identified that getting ready was the most stable activity, the fine grain events were tailored around this. The participant agreed that 'having a shower' was the most suitable and salient cue to attach to tooth brushing behaviour. Therefore, this participant agreed to place a tooth brush and tooth paste in the shower to remind him to brush at this time. Subsequently, an II was made which stated: "When I shower, then I'll brush my teeth".

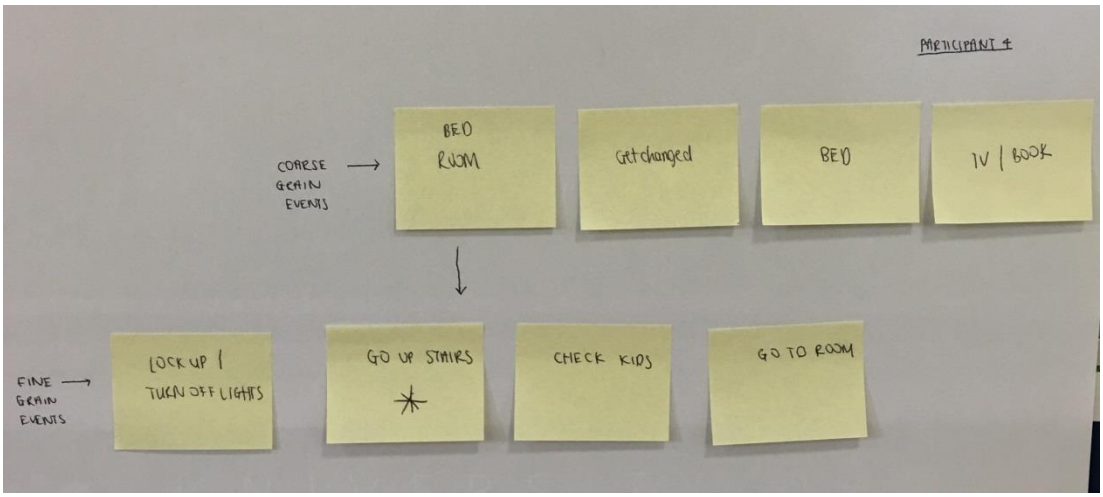
Picture 6.1 Post-it note intervention for participant 2



Participant 4 (Picture 6.2) reported her stable event as 'going to bed' and so 'BED' formed the initial coarse grain event. Subsequent coarse grain events were then discussed around this event. As the participant reported not wanting to leave the

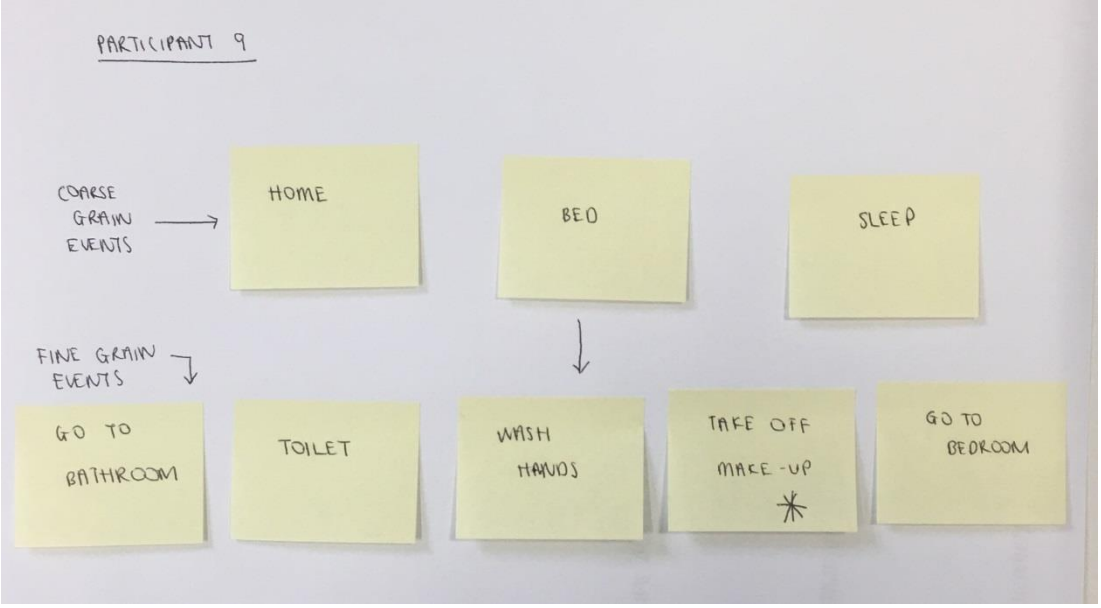
bedroom once there, it was decided to focus on the ‘events which lead to getting to the bedroom, forming the ‘fine grain’ events. It was identified that ‘going up the stairs’ was the most suitable and salient cue to attach to tooth brushing behaviour. Therefore, an II was formed around this cue for this participant.

Picture 6.2 Post-it note intervention for participant 4



Participant 9 (Picture 6.3) identified ‘bed’ as the most stable event, and so fine grain events were tailored around this activity. It was decided that ‘Take off make-up’ was perhaps the most salient and repeated cue to initiate tooth brushing. There was discussion around occasional lapses in this behaviour but, on balance, it was decided that this was a more stable cue that ‘going to the toilet’ which was reported to be missed more frequently.

Picture 6.3 Post-it note intervention for participant 9



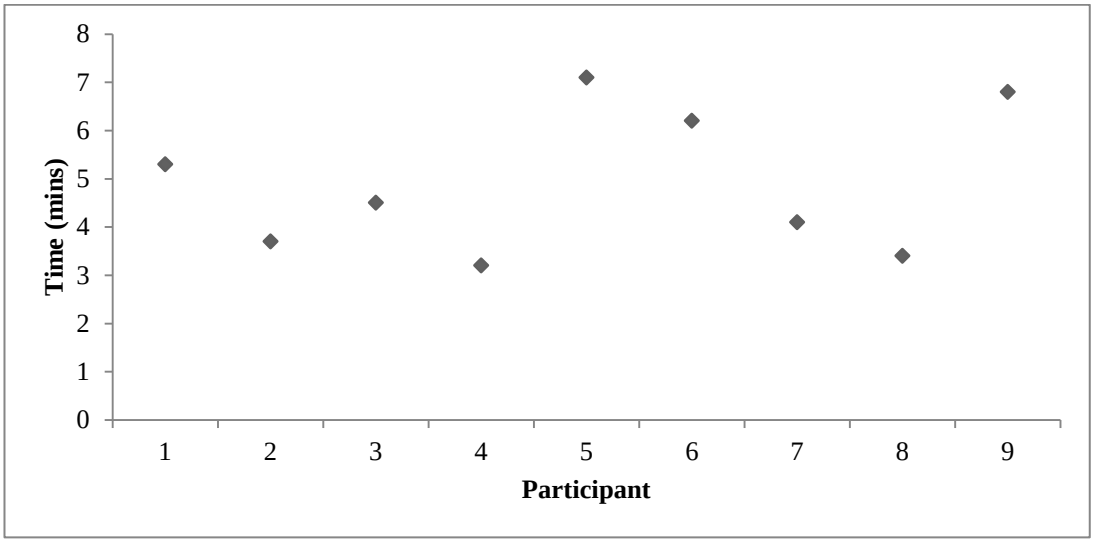
Other cues identified for the remaining participants are recorded in Table 6.3.

Table 6.3 Participants identified cues to initiate tooth brushing behaviour

Participant ID	New TB Behaviour	Cue
1	Evening	Going up the stairs
2	Morning	When I shower
3	Evening	When I go to the toilet
4	Evening	Going up the stairs
5	Evening	Going up the stairs
6	Morning	When I shower
7	Evening	When I take off my make-up
8	Evening	Going up the stairs
9	Evening	When I take off my make-up

Time taken to deliver the intervention (from the start when the opening question was asked to the identification of a salient cue) ranged from 3-7 minutes (Figure 6.3). All participants were able to give an almost immediate answer to the initial question, with an identifiable event coming straight to mind.

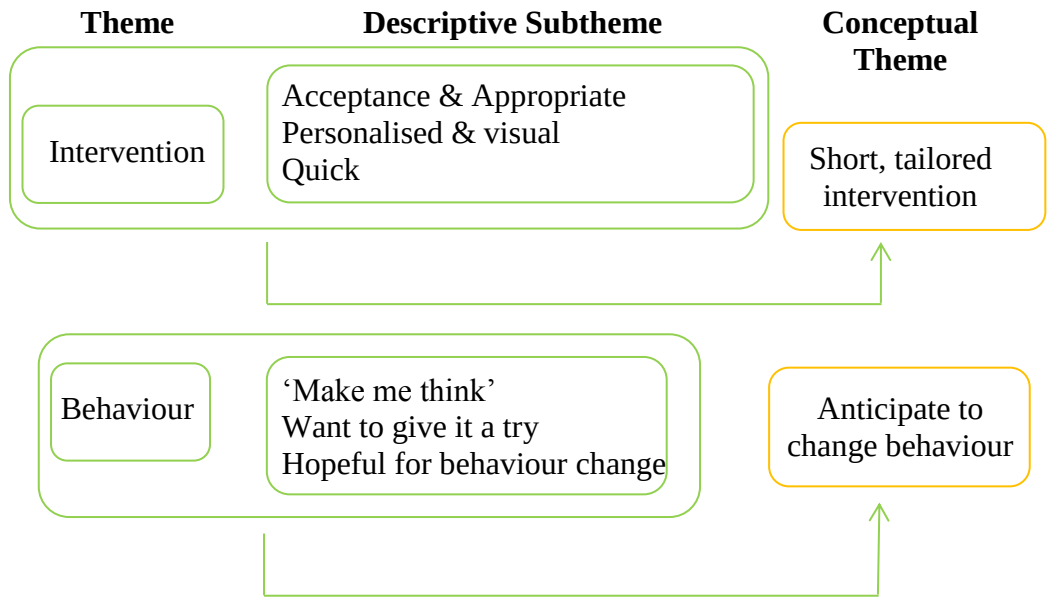
Figure 6.3 Length (in minutes) of intervention delivery



6.3.5.2 Participant feedback

Following the delivery of the intervention, participants were asked to feedback about the intervention. Two main discussion themes emerged (Figure 6.4) and these will subsequently be explored.

Figure 6.4 Framework matrix for data analysis



6.3.5.2.1 Intervention

This theme included discussion around the intervention and its components as well as the delivery. The first subtheme was the high acceptability of the intervention. All participants discussed their acceptance of the intervention and the appropriateness of delivery either within the dental setting or outside the dental context with an appropriate trained person.

> *'Yeah, if my dentist was to, mmm, yeah do something like this you know at my check up or whatever that's would be ok with that … equally I would take it from my doctor, yeah' (P4, Male)*

> And

> *'…don't see why people wouldn't be ok about it. It's just chattin' about what you do really…' (P9, Female)*

Another sub theme discussed by participants was around the personalised nature of the intervention. Participant reported it being 'easy' to see how they could apply the intervention to their own lives by attaching tooth brushing to an already existing event. Visualisation of their routines through the use of post-it notes allowed the individual to have something tangible to attach the tooth brushing behaviour against and this appeared a popular benefit of the intervention.

> *'It seems like a fairly simple process to chat about, like what 4, 5 minutes or something but mmmm, so yeah I think it would be good' (P2, Male)*

> and

'I think it is interesting to see what, what stops me from doing it … but I'll give it a try to do it' (P1, Female)

Finally, the last sub theme for the intervention was around the short delivery time. Participants felt that the brief intervention would be advantageous and more readily accepted.

'...yeah people are in a rush but this only took, what like, a few minutes, so no I think most people will be happy to chat it through… (P5, Female)

6.3.5.2.2 Behaviour

When discussing the impact participants felt this type of intervention may have on behaviour, all but one individual reported that they felt it would be helpful.

'..if I'm honest, I just don't think this is for me…' (P6 Male)

In particular, they discussed identifying a cue with the post-it notes and forming an II, by completing the II cards, would be more likely to remember to perform the desired tooth brushing behaviour and try to integrate it into their day. Participants appeared encouraged, reporting wanting to give it a try. Finally, participants reported being hopeful that this would result in behavioural change and that they would be able to establish twice daily tooth brushing.

'...yeah, I'm up for giving it a go' (P7, Male)

The one participant, who reported that he wouldn't find this intervention helpful, wasn't motivated to perform twice daily tooth brushing even after discussing some

motivating factors with him. The researcher encouraged the participant to at least give it some more thought when at home.

'...Honestly, I'm just not that bothered [to brush twice daily]' (P6, Male)

6.3.6 Discussion

This part of the study aimed to understand and develop the delivery of a habitual tooth brushing intervention with individuals with unstable or flexible routines. Having delivered the intervention to nine members of the public, initial results suggested that delivering a tooth brushing intervention in this way is quick and well accepted. It helps individuals to identify an opportune time to brush for the second time, as well as making an association between the predetermined (already existing) cue and tooth brushing behaviour by completion of an II.

The COM-B model for behavioural change as discussed in the literature review (section 2.2.1), reports that capability, motivation and opportunity all interact with each other to generate behaviour (Michie et al., 2011; Jackson et al., 2014; Michie, Atkins & West, 2014). As participants within this small exploratory study reported appropriate levels of motivation and high levels of capability to perform the tooth brushing behaviour. Perhaps this type of intervention helps to strengthen the opportunities component. By identifying an individual's cue to tooth brushing behaviour and forming IIs, this intervention appears to help prompt individuals to brush for the second time.

It appears that almost all participants recruited were at the 'Action' stage of the Transtheoretical model of behavioural change (Prochaska & DiClemente, 1982),

where they have already decided that they wish to develop a second tooth brushing behaviour. This intervention therefore acts in assisting participants to translate the decision into performance, although the study did not include measurement of this and so this is an area for further investigation.

Discussion around individual's routine was found to flow easily, with participants being able to identify their coarse grain and fine grain level events with ease, despite having unstable routines, such as working nights, differing shift patterns etc. In addition, some participants almost discussed their routine in fine grain level from the initial opening question, whilst others who were very broad in their discussion. Therefore, it was important for the researcher to remain adaptable to the participants recruited.

A number of study limitations must be noted. The first is the lack of follow-up of participants to explore the effectiveness of the intervention at establishing habitual tooth brushing behaviour. Whilst this would have allowed for a deeper understanding of the intervention and how it might impact on individual behaviour, this research piece was focused primarily around the delivery aspect of the intervention rather than its effectiveness. The second limitation of the study is the non-representative population sample, due to the snowballing sampling technique used. However, again, the aim was to explore if this type of intervention could be used for individuals who have varied and unstable routines so being representative wasn't important. Finally, results should be interpreted with caution due to the small sample size of only nine participants.

However, the initial findings appear promising and are informative in order to underpin a further, larger study. It is the first of its type to explore habitual intervention in the context of tooth brushing in adults from mainly a low socio-economic status.

6.3.7 Conclusion

This part of the study helps add weight to the argument that this intervention approach is potentially effective and feasible for delivery either within the dental context or outside the dental setting with a suitably training individual. It demonstrates that this type of intervention is acceptable to members of the public and is shown to be a quick, personalised one-to-one intervention which has the potential to can establish twice daily habitual tooth brushing behaviour.

6.4 Study B

Following on from the intervention development work in Study A, involving participants who were members of the public who had flexible or unstable routines, this part of the study started to look at the way in which this type of intervention might be delivered within a health setting for vulnerable population. Consideration was given to developing the intervention for use among a variety of different population groups but pregnant women was decided upon based on the information included below.

6.4.1 Pregnant women

6.4.1.1 Importance of oral health in pregnant women

Tooth brushing is particularly important for pregnant women. Both periodontal disease and caries can be exacerbated by pregnancy: gingivitis (inflammation of the gums) is aggravated by pregnancy fluctuations in oestrogen and progesterone and also influenced by changes to the balance of oral bacteria in the mouth and diminished immune responses (Laine, 2009; Silk et al., 2008). There may also be increased risk of decay because of possible sugar cravings (Farland et al., 2015; Murphey & Fowles, 2010). Indeed, a recent study from Thailand, reported pregnant women to be almost three times more likely to suffer from dental caries than non-pregnant women (Rakchanok et al., 2010).

In addition, and perhaps more importantly, the oral health and even the general health of the child can be influenced by the mother's oral health, risking both oral and general health inequalities being perpetuated in the next generation (Boggess and Edelstein, 2006). For example, periodontal disease in pregnancy has been linked to an increased risk of pre-term birth (PTB) which can have significant risks (such as respiratory distress syndrome, cerebral palsy etc.) for the baby (Puertas et al., 2017; Perunovic et al., 2016). As it is estimated that 11% of pregnancies end in PTB (Khader and Ta'ani, 2005), and approximately 40% of pregnant women have periodontal disease (Vamos et al., 2015), researchers have started to look towards oral health interventions as a possible means to reduce inequalities in adverse pregnancy outcomes. Moreover, PTB is not the only risk associated with periodontal disease in pregnant women - rates of preeclampsia and delivery of small-for-gestational age infants are also identified as other possible adverse pregnancy-related

outcomes (Khalighinejad et al., 2017; Shetty et al., 2010; Boggess and Edelstein, 2006).

In addition, a recent Cochrane review has been conducted on the treatment of pregnant women with periodontal disease to preventive adverse birth outcomes. (Iheozor-Ejiofor et al., 2017). In relation to preterm birth (<37 weeks), the review showed no clear difference between treatment and no treatment of periodontal disease (eleven studies). The quality of evidence was low and should therefore be interrupted with caution. The review also looked at differences in low birth weight (<2500g) between treatment and no treatment of periodontal disease. The meta-analysis showed a positive effect of periodontal treatment in reducing low birth weight (9.7% with periodontal treatment versus 12.6% without treatment; seven studies). However, as with the preterm birth, the quality of evidence as low and should therefore be interrupted with caution.

Therefore it is important to establish good oral hygiene practices in pregnant women as the benefit may be not only in relation to the mother but also to the unborn child as well.

6.4.1.2 Previous interventions to improve oral health behaviours of pregnant women

A recent systematic review of oral health promotion interventions during pregnancy found only 7 included studies, with none carried out in the UK (Vamos et al., 2015). All of these studies took an educational approach with the majority of interventions focused on improving the infants' oral health whilst neglecting the oral health and

behaviour of the mother herself. Modalities varied, including the use of oral instruction and audio-visual formats. Only two studies were RCTs (Cibulka et al., 2011, Vasiliauskiene et al., 2007) with both being mixed interventions (e.g. an educational component accompanied with the giving of dental supplies (tooth brush, paste, floss, mouthwash), a clinical application of fluoride varnish and arranging dental visit appointments). The two studies showed a significant improvement in the tooth brushing frequency of pregnant women in the intervention group, although follow up was limited to 12 weeks (Cibulka et al., 2011) and throughout pregnancy (Vasiliauskiene et al., 2007). The review concluded: 'more theory- and evidence-based interventions addressing the prenatal oral health guidelines using rigorous designs are needed' (pg 394, Vamos et al., 2015).

6.4.1.3 Using an intervention based on habit formation theory as a novel and theoretic approach to establish tooth brushing behaviours in pregnant women

Study A showed a habitual tooth brushing intervention has promise as a novel brief intervention, and so it was identified that this type of intervention may be beneficial, especially when delivered to pregnant women. Evidence for the cost-effectiveness of behaviour change interventions delivered in dental practice setting is equivocal (NICE, 2015), and so, delivery of this type of one-to-one intervention may be more appropriate outside the dental context. In addition, the vast majority of pregnant women engage in antenatal health care, and so was thought to offer a good participant base for intervention delivery, especially among women known to be of higher risk of poor oral health because of their socio-demographic background. Indeed, global data indicates that 81% of pregnant women visited antenatal care at

least once in the first three months of pregnancy in 2015, increasing to almost all women within developed countries (WHO 2014).

6.4.2 Study B aim and objectives

The aim of this study was:

- To develop and explore the delivery of a tooth brushing intervention based on habit formation theory targeted towards pregnant women attending for antenatal care in a clinic setting.

Objectives of this study were:

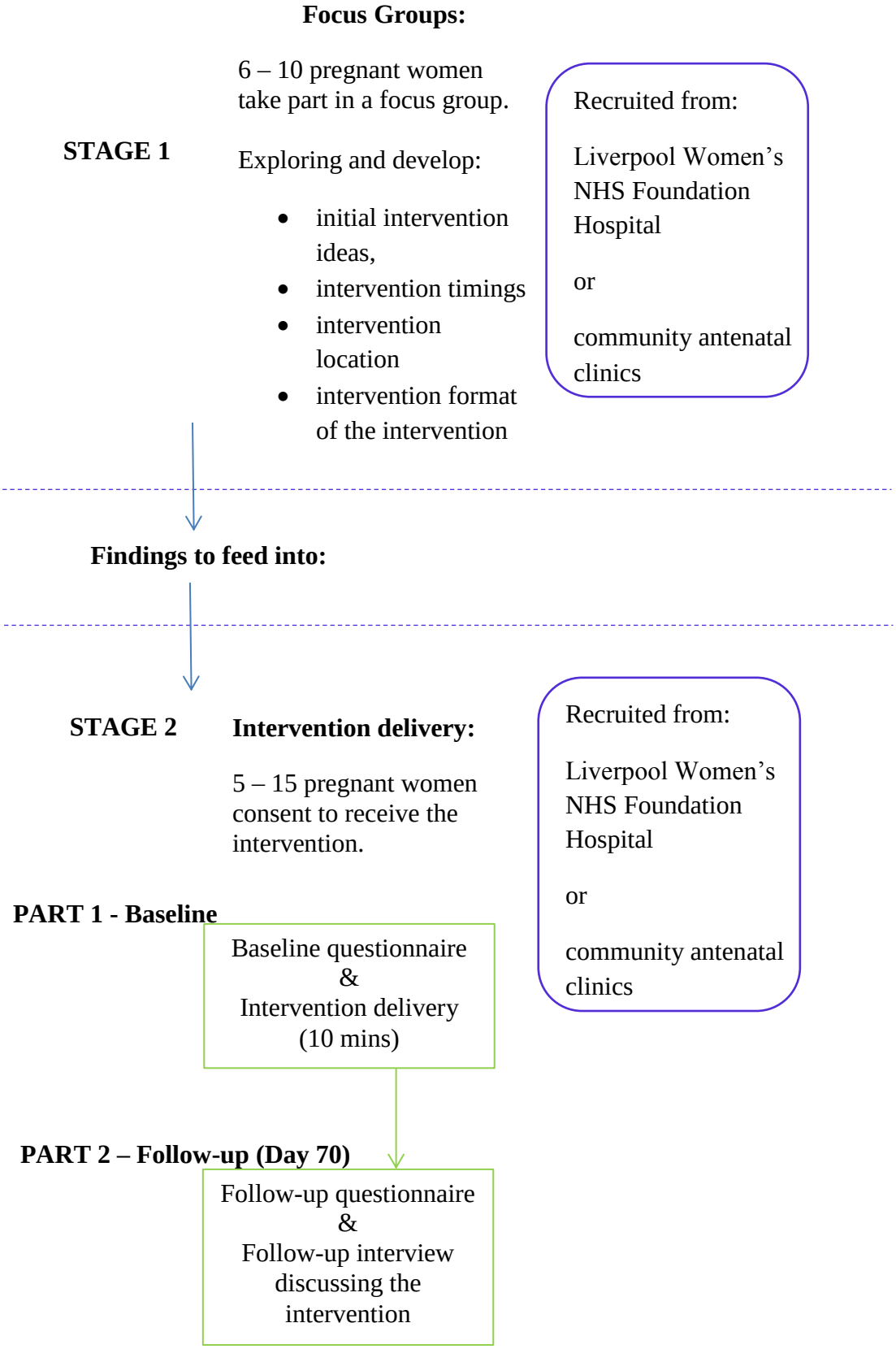
1. To explore the concept and practicalities of a tooth brushing intervention idea based on habit formation theory with women attending for antenatal care.
2. To delivery an intervention on a one-to-one basis with 5-15 women attending for antenatal care.

In order to achieve the above, it was decided to spilt the study into two parts (Figure 6.5).

STAGE 1 involved focus groups with pregnant women to gain a deeper understanding of how such an intervention might be successfully integrated into the care pathway for antenatal mothers.

STAGE 2 involved delivering the intervention to 5-15 pregnant women to assess delivery and acceptability issues.

Figure 6.5 Study Diagram: Tooth brushing Intervention for pregnant women



STAGE 1 – Focus Groups

6.4.3 Aim and objectives

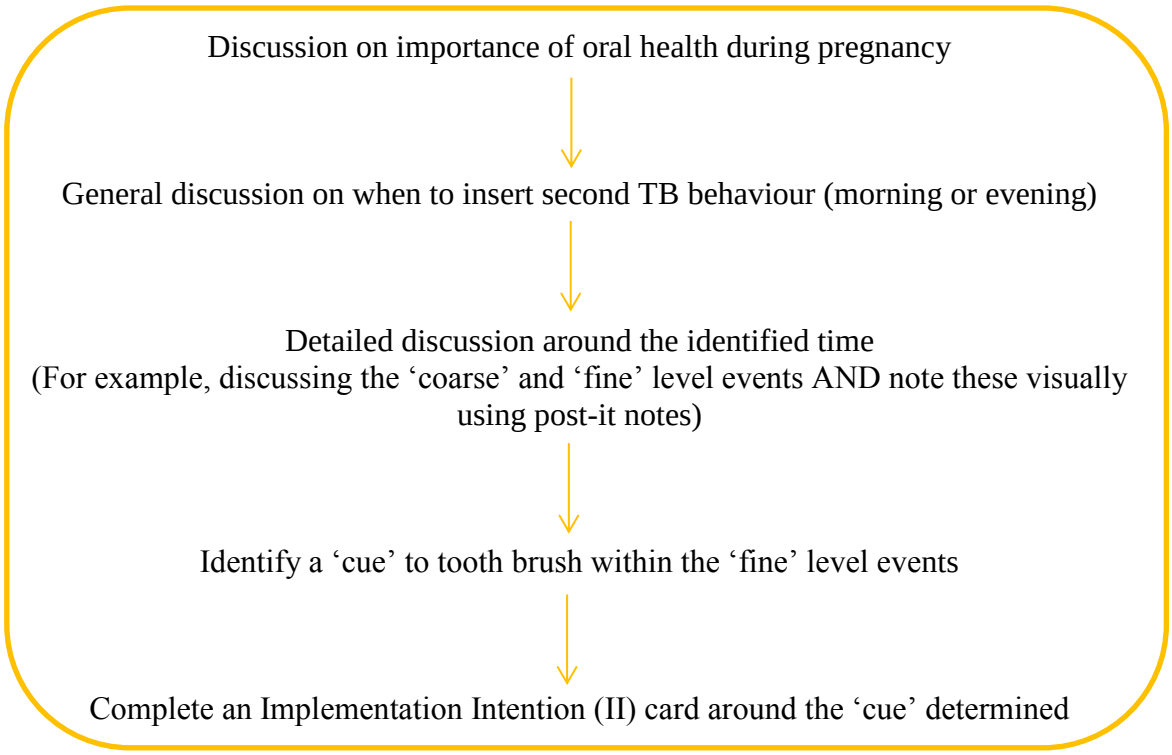
The aim of this study was:

- To undertake focus group work around the feasibility, concept and practicalities of a habitual intervention and how it might be further developed with pregnant women attending for antenatal care.

Objectives of this study were:

1. To determine acceptability and potential validity of screening mechanisms to identify eligible participants (those meeting inclusion criteria) i.e. once a day tooth-brushers.
2. To determine appropriate ways to approach women to inform them of the study and invite them to participate.
3. To determine feasibility, acceptability and practicality of using script elicitation methods to identify cues relevant to the tooth brushing intervention content.
4. To determine messages which are likely to increase capability, opportunity and motivation for tooth brushing among the target group.
5. To determine intervention timing (i.e. when the intervention would best be implemented during the pregnancy journey) .
6. To determine which of the following intervention formats are likely to be most feasible, practicable and acceptable: Tablet / PC based, paper-based, face-to-face with volunteers, online format.

Proposed intervention to be discussed:



6.4.4 Focus groups

Focus groups perhaps most strongly originate within marketing research where researchers were interested in how participants choose products, viewed product designs, how they viewed advertising etc (Krueger & Casey, 2009). By bringing together a group of individuals, focus groups allow data to be generated through the discussion and exploration of ideas through interaction between individuals. It is thought that each individual draws out or enhances the meaning of each point discussed (i.e. fully explain and discuss their viewpoint) which helps to move responses towards a 'deeper and more considered level' (Ritchie et al., 2014, pg212; Tausch & Menold, 2016; Coenen et al., 2012). Focus groups represent a method in which data can be collected from more than one person at one time period, which advantageously reduces time and cost burdens (Kitzinger, 1995). Topic guides help

to guide the group discussions to explore the topic areas required (Stewart et al., 2007).

Focus groups have been used within healthcare to explore a number of different topics (Rasmusson et al., 2014; Feldthusen et al., 2013; Gerber et al., 2012; Daley et al., 2010). In addition, they have been used to explore, with an ethnic minority group, how to effectively deliver a diabetes self-management intervention (Vincent et al., 2006). Within this study, participants discussed intervention adaptation for the target cultural group as well as detailing other aspects of the intervention deemed important to Latino Americans, such as incorporation of a stress management component. This depth of knowledge was produced due to the interactive and exploratory nature of the focus group.

As this part of study aimed to explore the concept and practicalities of a habitual intervention and how it this might be applied to pregnant women within an antenatal care setting, focus group methodology was appropriate.

6.4.4.2 Limitations in focus groups

However, limitations of focus groups are also noted. At discussed in the qualitative study on the nature of tooth brushing behaviour (chapter 4, section 4.2), focus groups may cause a 'polarization effect' (Morgan, 1996), where outcomes in data generation are guided by the consensus of the group rather than individual opinions. In addition, questions have been asked about the control the researcher (usually termed the moderator in focus groups) has over the group (Gill et al., 2008). However, with the

development of a topic guide, it was anticipated that these limitations will be kept to a minimum.

6.4.5 Methods

6.4.5.1 Study design

6.4.5.1.1 Ethical approval

Ethical approval was obtained by the National Health Service (NHS) Research Ethics Committee (London – Dulwich Research Ethics Committee), reference 17/LO/0696. NHS research governance approvals were obtained prior to commencing the study (Appendix 8).

6.4.5.1.2 Recruitment

An established PPI (patient and public involvement) group at Liverpool Women's NHS Foundation Hospital agreed to form an initial focus group. The second focus group was taken from a community pregnancy group '!Audacious Mums'. Individuals within the group were approached (via telephone/email) and invited to take part in the focus group. After checking for eligibility, information about the focus groups (i.e. aim, objective and rough outline of the proposed involvement) was given. Those identified as willing to participate were given an option of three different dates and times to attend a focus group, with the most popular time being used. Consent forms were signed on the day of the focus groups with participants free to decline from taking part at any point.

6.4.5.1.3 Setting

Focus groups took place at the Liverpool Women's NHS Foundation Hospital and at one of the community participant's own home, all within a confidential environment. Field notes were made during the interviews to assist with reliable reconstruction of the focus groups.

6.4.5.1.4 Conduct

Conduct of both focus groups was completed using the five stages recommended by Ritchie et al. (2013). These include:

1. Scene-setting and ground rules

This included ensuring that all participant were aware of the aim of the focus group and understood that they were free to leave or could withdraw their consent at any point. The researcher (moderator) also set out how the group would be conducted.

2. Individual introductions

Individuals were encouraged to introduce themselves so that everyone in the group knew who each person was and their pregnancy background.

3. The opening topic

The opening topic used within this focus group was centred around what participant knew about oral health and pregnancy. An open ended question was used to explore this information.

4. Discussion

The remaining discussion was guided by the use of a topic guide (appendix 9). This topic guide was initially constructed to explore the questions raised within the objectives of this piece of work and included determining when delivery of

intervention would be optimal, how the intervention could be delivered. This guide remained flexible to allow for questioning of emerging data.

5. Ending the discussion

When the topics on the guide had been adequately covered, participants were thanked for their time and were informed that the group had come to an end. Participants were also given the researcher's contact number and e-mail address for any further follow up questions they may have.

All interviews were audio-taped and transcribed as soon as possible for analysis.

6.4.5.1.5 Inclusion / Exclusion criteria

Inclusion criteria:

Participants were required to be adult women (aged 18+ years) who were using or had used antenatal services and so could give a reflective view on the proposed intervention. Ideally, recruitment of women who were pregnant (in their second or third trimester (i.e. 12+ weeks) was considered optimal but consideration was given to those individuals who had recently given birth and could reflect on their pregnancy journey with accuracy. Participants were required to have the capacity to give their own informed consent and be able to independently brush their teeth.

Exclusion criteria:

Participants were excluded for inclusion if they were under the age of 18 and, unfortunately, individuals who do not adequately understand spoken and/or written English as translation was not possible.

6.4.5.1.6 Sample and sample size

Purposive sampling, via a sample matrix was undertaken to ensure a mixture of participants within each focus group. The reason for purposive sampling is discussed in chapter 4, section 4.4.1.6. The sample matrix included individuals from a mixture of socio-economic status (as measured by postcode) and age (Table 6.4).

Table 6.4 Sample Matrix for PART 1(focus groups)

Characteristics	Number
Tooth brushing frequency Twice daily Once daily	 Min 2 Min 1
SES (based on postcode of home address) High (1st IMD quintile) Medium (3rd IMD quintile) Low (5th IMD quintile)	 Min 1 Min 1 Min 2
Age (years) 18 – 24 25 – 34 35 – 50	 Min 1 Min 1 Min 1

6.4.5.2 Analysis

Whole group (rather than participant-level) analysis was undertaken and included the formulation and evolution of views over the course of the group with particular interest in areas of disagreement between participants, affirmation of participants or discussion points which bring conflict etc. Again, similar to that of study 2, chapter 4, the framework method of thematic analysis was used to analyse the data (Gale et al., 2013; Braun & Clarke, 2006). NVIVO was used to code the data into categories developed from the theoretical literature on habitual behaviours. This initially included broad themes such as ‘WHAT’, ‘WHEN’, ‘WHO’ etc. An ‘other’ code was

also included to allow for coding of important data that did not fit into the pre-determined codes. Initial data analysis took place after the first focus group and prior to conducting the second focus group to ensure that emerging themes were nested into the second focus group to explore and test further. The main data coder (HR) also conducted the interviews. To ensure rigour, in addition to the active analytic process, the researcher remained responsive (i.e. open and sensitive) to evolving data with emergent findings and analysis also tested with a wider analytic team (Morse et al., 2002). For example, coding was discussed at supervisory meetings to ensure agreement and to discuss the grouping of codes into categories.

6.4.6 Results

Two focus groups were conducted. This involved 12 participants in total. Table 6.5 gives an overview of the participant characteristics of included participants in both focus groups. Focus group 1 consisted of four participants and lasted 1 hour 11 minutes whilst focus group 2 consisted of eight participants and lasted 1 hour and 58 minutes.

Table 6.5 Participant characteristics of focus groups

Focus Group 1

Participant	Age	Ethnicity	Pregnancy Status	No. of pregnancies
1	45	White British	Not pregnant	3
2	35	White British	Not pregnant	4
3	41	White British	Not pregnant	2
4	29	White British	Not pregnant	3

Focus Group 2

Participant	Age	Ethnicity	Pregnancy Status	No. of pregnancies
5	35	White British	Not pregnant (4 months post delivery)	1
6	27	White British	Not pregnant (7 months post delivery)	1
7	35	White British	Pregnant (6 months pregnant)	2
8	28	White British	Not pregnant (9 months post delivery)	2
9	36	White British	Not pregnant (4 months post delivery)	3
10	24	White British	Not pregnant (10 months post delivery)	1
11	32	White British	Pregnant (3 months pregnant)	2
12	26	White British	Not pregnant (8 months post delivery)	3

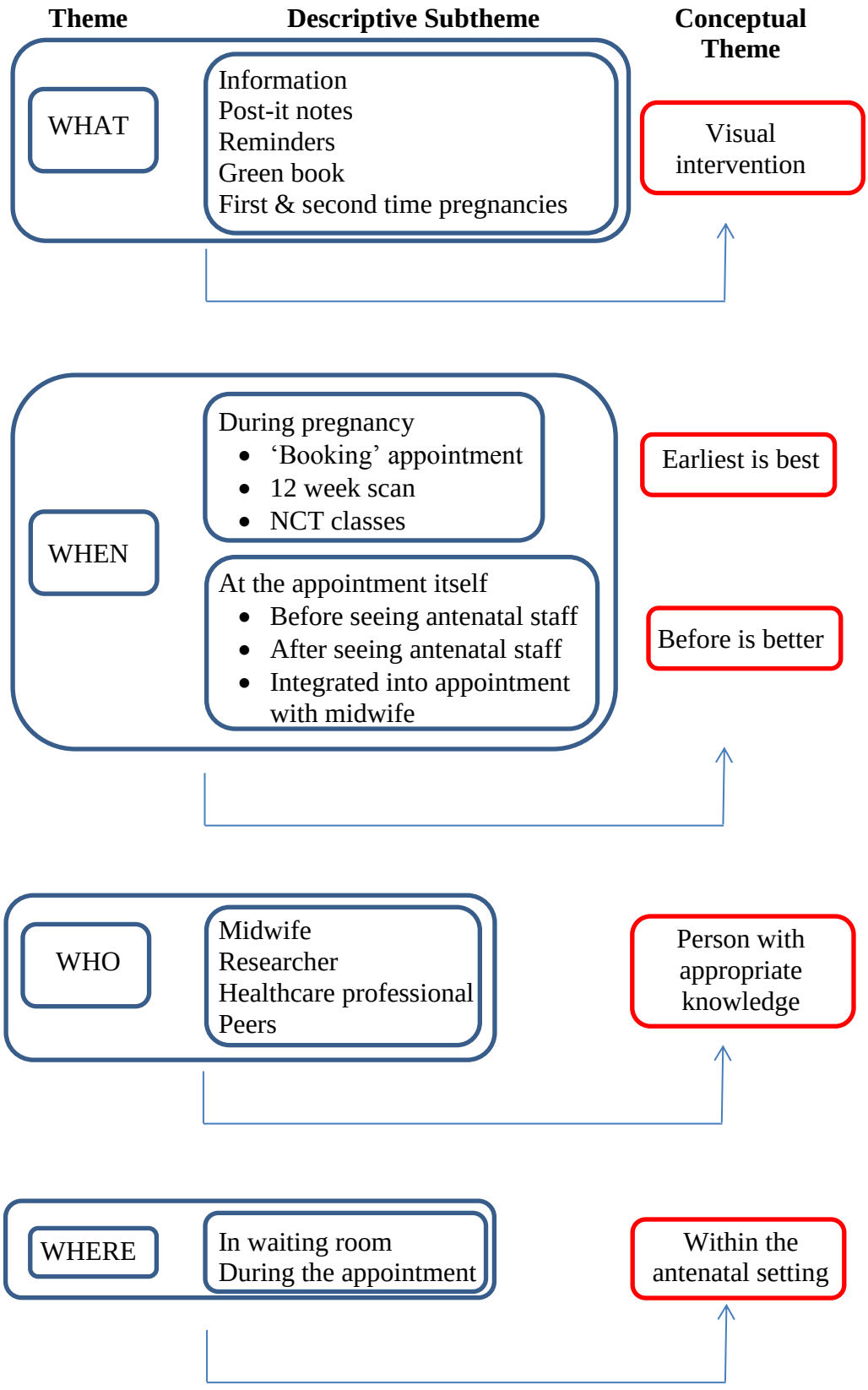
In the results, focus group 1 data is identified as FG1 and focus group 2 as FG2. Data from participants as P1-P12 according to Table 6.5.

6.4.6.1 Theme development

On becoming familiar with the data obtained from the two focus groups, and reflecting them back upon the objectives of this study, four dominant descriptive themes emerged from the data coding. These included: ‘WHAT intervention to deliver, ‘WHEN to deliver the intervention’, ‘WHO should deliver the intervention’ and ‘WHERE to deliver the intervention’. These four themes made up the foundation

for the framework analysis matrix. Sub-themes were also noted within each theme, and combined with the overarching theme, were analysed to produce concepts as part of the final framework (Figure 6.6). Five conceptual themes emerged from the themes and these include: ‘visual intervention’, ‘earliest is best’, ‘before is better’, ‘non-clinical staff member’ and ‘within the antenatal setting’.

Figure 6.6 Framework matrix for data analysis



6.4.6.2 'WHAT intervention to deliver'

The first theme within the matrix was 'WHAT intervention to deliver'. This included discussion around the proposed intervention and was an extension of the work conducted in Study A, which explored this intervention with the general public. Particularly, this theme was focused on participants talking through the intervention and applying it to pregnant women.

One of the first sub-themes which emerged from the data was around information. Participants within the group talked about their lack of knowledge of the importance of oral hygiene practices during pregnancy, due, in their opinion, to the lack of information provided at the start of their pregnancy. No participant reported being given information in an antenatal care setting to encouraging them to brush their teeth more frequently. Almost all participants within the group reported having wanted to have received the information so they could make an informed decision on their oral self-care.

> ***'I*** ***….what did you guys know about tooth brushing in pregnancy?***
>
> *P5* *Nothing.*
>
> *P7* *I knew nothing.*
>
> *P12* *(quite a few) Nothing yeah.*
>
> *R11* *Me too.'*
>
> *(FG2)*

When oral health information was provided to women at antenatal appointments, it was centred on two main points:

1) Free dental care and therefore suggested to go see the dentist

'I don't think I was told anything other than she said oh you can get like free dental care and that was it never said anything else.' (P2, FG1)

2) The importance of ensuring they brush their children's teeth

'There was loads of booklets about brushing your baby's teeth but nothing about me.' (P6, FG2)

Another sub-theme was around 'Post-it notes'. In particular, and like the results demonstrated in Study A, participants found it helpful to have the visuals laid out in front of them to help to 'map out' their routines. Participants reported the helpfulness of having some generic post-it notes formulated so to help the progress, and perhaps, in their opinion this would reduce the time taken to complete the intervention. Participants felt the II component of the intervention helped in the translation of what the 'bottom line' of the intervention was.

'…it's really good to see it all laid out like this [post-it notes], helps to like see …mmmm… what you are want to do…' (P10, FG2)

Reminders populated another sub-theme within the analysis. In particular, and in both groups, suggestions around using the reminder app on mobile phones may be effective. Both groups reported the physical attachment people have to their phones and suggested the high incidence of having your mobile phone on you in person to alert you to brush your teeth at the appropriate time.

'Yeah cause everyone has always got their phone stuck to them haven't they, no matter what is going on around them, the phone is the thing to survive!' (P1, FG1)

'…because they have their phones attached to them all the time, even I do you have your phone with you all the time especially when you are going to be, up to bed or to bed or whatever you will take your phone with you cause you will put it on charge or whatever next to your bed, cause you use it so actually you will take it in the bathroom with you or you would and having a reminder' (P9, FG2)

Others suggested using the pregnancy apps already in public circulation and attaching a tooth brushing reminder to this app. The participants reported reading the information available on the apps regularly and so would find attaching a reminder to this helpful.

'The other thing that everyone does like you get those apps don't you that tells you that your baby is the size of a kiwi or something….they might be useful to use as a like reminder…' (P9, FG2)

In addition, participants felt that even simple measures like placing the reminder card (the Implementation Intention card) in a visible area near the predetermined cue, would remind the women to brush their teeth. For example, if a participant had decided their cue to initiate tooth brushing was after the evening meal, participants suggested leaving their II card at the sink with a tooth brush, which would prompt behaviour when either washing up or leaving the dishes at the sink.

Participants also discussed how the 'green book' (patient notes/records, kept with all pregnant women until delivery) could be used to help begin the discussion around oral hygiene practices within the appointment itself. Participants felt, particularly

within the community group (focus group 2), that this would encourage conversation around the importance of tooth brushing and might be an opportune moment to deliver the brief intervention.

> *'You know the green book that you get at the start, if it was a tick box in that…' (P8, FG2)*

Finally, within this section of analysis, a dominant descriptive sub theme was focused around the possible differences in woman expecting their first or multiple pregnancies. They discussed the differences in appointment frequencies, such that, those who are having their first baby, visit the antenatal team significantly more times than those who are on their subsequent baby. In addition, participants also considered this type of intervention to be more effective for 'first time' pregnant women as they would be perceived as being more receptive to the information. Participants reported that perhaps second time mums, for example, may feel it less important to brush their teeth as they were 'ok' last time. This may impact the effectiveness of the intervention.

> *'I think it might be good if you target new mums because they are eager to do the right thing, sometimes if people have had other children it's like well it done them no harm last time…' (P4, FG1)*

In addition to this, participants felt that having other children might impact intervention delivery due to having to pick other children up from childcare whilst at the appointment or having the children present with them at the appointment.

The conceptual theme that emerged for the 'WHAT intervention to deliver' was a 'visual intervention'. Overall, participants felt that an intervention which can be visualised (in post it note form) reinforced with a simple reminder set on their mobile phone would be effective for pregnant women.

6.4.6.3 'WHEN to deliver the intervention'

6.4.6.3.1 During pregnancy

When to deliver the intervention during pregnancy was discussed at length in both focus groups. Predominantly three time points were discussed. These include:

a) Booking in appointment

This appointment was discussed as an optimal time to deliver the intervention for a number of reasons. Delivery of the intervention at the start of the pregnancy was felt to be very important in principle. At this appointment, participants discussed being asked a lot of personal questions and so they would perhaps feel more comfortable being asked about their tooth brushing behaviours and might encourage a more honest self-report of their current tooth brushing behaviour.

> *'To be honest you know when you have been asked if you are genetically related to the father of your child in any way I was thinking about oral hygiene it seems like quite an easy question and then if they answer, if I am honest "No I don't" or "less than once or whatever"….' (P11, FG2)*

b) 12 week scan

Another time identified was the 12 week scan, when woman often find themselves waiting for long periods of time for their scan with the sonographer. Some participants felt that this would help pregnant women, as it would offer them

'something to take their mind off the scan'. However, other participants felt that this appointment caused significant anxiety concerning the results of the scan and so women may have a reduced ability to focus on the intervention being delivered.

'And you don't want to be like, you are about to have your scan so you don't know if the baby is, like you don't know anything about the baby yet...

R all Yeah it is scary.' (P3, FG1)

c) NCT classes

Finally, delivering the intervention at NCT (National Childbirth Trust) classes may be successful as the environment is more relaxed and often there is more time for discussions. However, these classes often occur later in the pregnancy (30-32 weeks pregnant) and are often only attended by first time parents.

'And what about including something in and I know not everyone goes but the antenatal classes, including some of that...' (P1, FG1)

6.4.6.3.2 At the appointment itself

Participants discussed implementing the intervention before or after the antenatal appointment. Before the appointment was noted as potentially more successful for recruitment because, firstly, often the length of time which is required to complete each appointment means women would be unlikely to stay for 'another thing'. Secondly, woman may also need to 'rush off' to complete other important daily tasks, such as collecting other children from school etc.

'Before the appointment should be fine, afterwards you have got no chance of catching them, especially if its been a long appointment…' (P4, FG1)

Therefore, two conceptual themes emerged: ‘earliest is best’ and ‘before is better’. Overall, participants within the focus groups reported the importance of delivering the intervention at the earliest stage possible and if this is to occur at an antenatal appointment, before the appointment (rather than after) is better.

6.4.6.4 ‘WHO should deliver the intervention’

Debate within the transcripts is noted around who should deliver the intervention. Some participants within the group (predominantly FG1) felt the intervention would be best delivered by a peer or a researcher who can distance themselves from the antenatal appointment itself. It was discussed that this might encourage honest answering around the pregnant woman’s tooth brushing behaviour. In addition, participants suggested that pregnant woman would want to appear to be doing ‘all the right things’ for their unborn child and so this would encourage higher self-report. However, other participants within the group felt the midwife would be best placed to deliver the intervention during the antenatal appointment itself. High levels of trust are placed on midwifes by pregnant woman and so their recommendations would be considered to have high value.

Finally, others reported that who delivers the intervention is not important, as they would be open to receiving information about brushing their teeth with any member of the healthcare team. In addition to this, participants discussed the lack of understanding around the ‘who’s who’ of the healthcare setting and so information and intervention delivery could be delivered by any individual with appropriate knowledge.

'Someone who looks like they know what they are talking about in my opinion…'

'I would never even think to ask what their position was, if they were talking to me about something like that [importance of oral health]…'

'People don't know the difference between positions…..' (P11, FG2)

Therefore, the conceptual theme emerged: 'person with appropriate knowledge'. Overall, participants felt that any person with appropriate knowledge, either researcher, peer, or healthcare professional would be adequately received to deliver the intervention to encourage development of a habitual tooth brushing intervention.

6.4.6.5 'WHERE to deliver the intervention'

Two main areas were discussed as potential areas to deliver the intervention. This included in the waiting room and in the clinic during the appointment itself. Participants reported that this would depend on who was delivering the intervention. As long as both allowed for a confidential discussion, either location would adequate.

Therefore, the conceptual theme emerged: 'within the antenatal setting' as participants overall felt that delivery anywhere within the setting would be appropriate.

6.4.7 Discussion

It is important to understand how a habitual tooth brushing intervention may best be delivered to pregnant women by exploring this concept with pregnant women themselves.

In summary, the outcome from the analysis of the focus groups suggested a visual intervention delivered as early as possible within the pregnancy journey would be most effective. Also, delivering the intervention before the antenatal appointment was considered to be logistically more suitable than after. The intervention could be delivered by any person with appropriate oral health knowledge within the antenatal setting and be taken with the same weight.

6.4.7.1 Oral health information

All women reported the lack of information about the increased vulnerability to either periodontal disease or dental caries during pregnancy. A recent cross-sectional survey conducted in Sydney, Australia also demonstrated similar results: only 10% of respondents has received any form of oral health information throughout their pregnancy (George et al., 2013). Provision of adequate information to encourage health promotion does not seem to be standard practice in the antenatal context. Whilst literature suggests knowledge doesn't relate to sustained behavioural change (Gao et al., 2014; Kay & Locker, 1998) (see literature review chapter, section 2.7), the COM-B model for behavioural change recognises knowledge as a way to increase 'capabilities' for behavioural action (Michie et al., 2011).

6.4.7.2 Reminders

Reminders have been suggested within the focus group to be helpful to remind participants to brush their teeth. Indeed, reminders have been used successfully within the health care setting. For example text message reminders have been used with success to increase physical activity (Fanning, Mullen & McAuley, 2012; Webb et al., 2010; Prestwich, Perugini, & Hurling, 2009), and to increase medication adherence (Kannisto, Koivunen & Välimäki, 2014).

In addition, text messages have been used successfully within dentistry. Text reminders to increase attendance for dental appointments have shown to be effective (Prasad & Anand, 2012; Perry, 2011; Foley & O'Neill, 2009). Indeed, a recent text message intervention was delivered to 129 mothers of young children (5 years or younger) recruited from both private paediatric dental practice and paediatric community dental clinic (Hashemian, Kritz-Silverstein & Baker, 2015). Text messages were sent to participants for 7 days which asked participants within the intervention group 'Did you floss yesterday?' Participants who responded to the text were subsequently texted a follow up text with oral health/hygiene information. Post intervention questionnaires were completed 1 day after cessation of the text messages. Analysis showed participants within the text group flossed more and also tried to improve the oral health behaviours of their children at post intervention (day 8) than baseline. However, the follow up period for this text message intervention was only 1 day and so whether behaviour change was sustained has not been clearly established. As documented in the literature review chapter (section 2.2.2), habit formation theory suggests that an average period of 66 days are required for the establishment of simple habitual behaviours (Lally et al., 2010).

Whilst phone reminders may appear to be helpful to establish habitual behaviour, caution around their use should be considered. Habitual behaviour is initiated by cues and so care must be taken to ensure tooth brushing behaviour doesn't become cued by the reminder on the mobile device but rather on a more stable, longer term cue, such as washing your face.

In addition to mobile phones, participants also discussed the possible effectiveness of placing a reminder card (the II card) in an area near the predetermined cue. This is in keeping with the findings from the qualitative study on tooth brushing behaviour (section 4.5.2) which reported on the power of external visual cues have on the initiation of tooth brushing behaviour, and suggests that future intervention may benefit from containing this component.

6.4.7.3 Social acceptability

Within the focus group discussions, particularly when considering who could deliver the intervention, there was a strong social acceptability of twice daily tooth brushing behaviour and perhaps even a feeling of social judgement if reporting to brush less than the optimal twice daily recommendation. This has been demonstrated in other health behaviours, such as healthy eating (Higgs, 2015), where food and drink choices and consumption are influenced by accepted social norms (Hermans et al., 2012; Larsen et al., 2010).

Careful consideration should be given to this issue as response bias to self-report questions may arise if used as part of eligibility criteria. However, on balance, the focus groups determined a peer or researcher would be best to discuss tooth brushing

behaviour, as it was thought that this would encourage more honest answering to tooth brushing frequency questions and reduce feelings of social judgement.

6.4.7.4 Limitations

A number of limitations have been acknowledged. All recruited participants within the focus groups in this initial exploratory study have a White British ethnicity and so the thoughts of women from different ethnic backgrounds have not been incorporated. However, there are no reasons why most general principles discussed within the focus groups would probably not be generalisable to other groups of pregnant women.

Also, focus group 1 was conducted with only four participants. Although an original number of six was recruited, only four participants showed up at the allocated time on the day. It was therefore decided to continue with a second focus group to gather further data on thoughts and opinions around delivering a habitual tooth brushing intervention.

6.4.8 Conclusion

Part 1 of Study B helps understand how a habitual tooth brushing intervention may be delivered to pregnant women. It appears that this type of intervention would be accepted within the antenatal setting, where pregnant women would be open to receive information to help improve their oral health. Delivering the intervention as early as possible in the pregnancy journey is considered more important than the individual delivering the intervention itself.

Therefore the next part of the study looks at delivering the intervention within the antenatal setting, taking into consideration the results of the focus groups. This is reported in the next section.

STAGE 2 – Intervention delivery

6.4.9 Aim and objectives

The aim of this study was:

- To explore the potential of delivering a tooth brushing intervention based on habit formation within an antenatal setting.

Objectives of this study were:

1. To test the acceptability and potential effectiveness of the intervention developed.
2. To explore the delivery of this intervention by identifying specific issues/problems with recruitment, number of eligible participants, assess likely consent rates, reasons for non-consenting, and any possible barriers and facilitators to study recruitment.
3. identify appropriateness of intervention timing and feasibility of delivering the intervention in this setting.

6.4.10 Methods

6.4.10.1 Study design

6.4.10.1.1 Ethical approval

Ethical approval was obtained by the National Health Service (NHS) Research Ethics Committee (London – Dulwich Research Ethics Committee), reference 17/LO/0696.

NHS research governance approvals were obtained prior to commencing the study (Appendix 8).

6.4.10.1.2 Setting

After consultation with professionals at Liverpool Women's NHS Foundation Hospital, it was decided to conduct this study at the Liverpool Women's NHS Foundation Hospital and also at community clinics in North West England. This included one at Five Children's Centre in Speke, Liverpool and one at the May Logan Healthy Living Centre in Bootle, Liverpool. It was considered useful to attempt to recruit from both primary care centre and secondary care centre to understand how the delivery of the intervention might differ depending on the care setting.

6.4.10.1.3 Recruitment

As one of the key messages from the focus groups highlighted the importance of early delivery of intervention, i.e. at the start of pregnancy, it was decided to deliver the intervention at the 'booking' appointment. This appointment is normally the first time a pregnant woman will have received antenatal care, and normally takes place at around 8-12 weeks pregnant.

On booking in for their 'booking' appointment, each pregnant woman was informed of the research that was taking place. Those wishing to take part, then completed eligibility screening with the researcher before consent documents were issued, discussed and signed. A recruitment log was kept to record characteristics of those declining in the study alongside reasons for not participating if given.

6.4.10.1.4 Intervention delivery

Intervention delivery was the same at both the community and the hospital locations and occurred at the 'booking' appointment.

PART 1 - Baseline

After confirming eligibility and signing consent, participants were asked to complete a short questionnaire (via an iPad using the Qualtrics platform), which included:

- Demographic characteristics such as age, ethnicity & SES (measured by IMD identified using home postcode)
- Intention was also measured (Ajzen, 2006). Using a 7-point Likert scale (1=very unlikely to 7=very likely), participants were asked to select the most appropriate response to the statement: 'I intend to brush my teeth for the next 3 months'. Higher scores indicated higher levels of intention
- Tooth brushing frequency. Participants were asked: 'Normally, how often do you brush your teeth?' with participants able to choose from the following responses: twice a day; once a day; once a week; once a month; less than once a month; other. It is in line with the Adult Dental Health Survey (Office of National Statistics, 2012).
- Self-report behavioural automaticity index score for both morning and evening tooth brushing. It was collected using the validated self-reported behavioural automaticity index (SRBAI) (Gardner et al., 2012) (see chapter 5, section 5.4.3.3 for an example of the question). Higher scores indicated higher levels of automaticity.

In a confidential environment, usually an allocated consultation room within the community centre or hospital, the researcher aimed to deliver the brief intervention. This comprised exploring the participant's routine via the use of post-it notes and documenting in coarse and fine gain detail the behaviours normally conducted around the time for insertion of tooth brushing behaviour (see section 6.2.4.1.4). The researcher then facilitated the participant to form an II around the cue to initiate the behaviour. Once the participant left the confidential area, the researcher documented on the iPad, the individual's routinised behaviour by taking a photograph of the post-it note activity and their identified cue for tooth brushing initiation.

In addition, detailed field notes were written to aid documentation of any issues or important points of note and also to note participant's interaction with the intervention, paying particular attention to concept and content, timing and general attitudes towards the intervention expressed during interactions with the participant.

PART 2 – Follow-up

A second contact was made by telephone at 70 days (10 weeks) post intervention delivery. Seventy days was chosen as evidence suggests, for simple behaviours, this is when the majority of individuals will have reached maximum automaticity of behaviour (Lally et al., 2010). Participants reviewed consent and arranged a suitable time for a follow-up semi-structured interview to be conducted. In-person interviews were conducted in a preferred public location (i.e a local café).

Prior to commencing the interview, participants were invited to complete a second questionnaire, identical to that at baseline to assess for changed in self-reported automaticity values.

The interview itself was designed to discuss the intervention and how it translated into the context of their every-day life. Questioning also explored whether a tooth brushing habit had been established, limitations to establishing habitual tooth brushing and any other important thoughts participants had around tooth brushing behaviour. The topic guide to help structure the interviews is included in Appendix 10. All interviews were audio-taped and transcribed for analysis.

6.4.10.1.5 Inclusion / Exclusion criteria

a) Inclusion criteria:

Adult pregnant women aged 18+ years who have the capacity to give their own informed consent were included for recruitment. Participants had to be able to independently brush their teeth as this affect the habit formation process. It was expected that if woman were further on in the pregnancy but attending for their 'booking' appointment they were still considered for inclusion. As this was a tooth brushing intervention, all woman recruited had to report brushing less than twice daily on at least 4 days throughout the week.

b) Exclusion criteria:

Participants were excluded if a stable contextual environment was not possible to achieve, i.e. homeless, or those who did not have the capacity or opportunity to brush their teeth. Individuals who did not adequately understand spoken and written English were also excluded due to the limitations of resources for translation.

6.4.10.1.6 Sample size

As this was an exploratory study aim to explore the possibility of delivering a habitual tooth brushing intervention to pregnant adults within an antenatal setting, it was expected that recruitment would be between 5 to 15 pregnant adult women. This number is in keeping with other exploratory healthcare studies which have explored intervention development in a similar way (Lally, Wardle & Gardner, 2011).

6.4.10.2 Analysis

6.4.10.2.1 Questionnaire analysis

Data collected from the baseline and follow-up questionnaire was statistically analysed using SPSS v 22.0 software. A p value of less than 0.05 was considered significant. For continuous variables, data was expressed as median and interquartile range (IQR) whereas numbers and percentages were used for categorical variables. Based on previous studies, the relationship between repetition of behaviour and automaticity level was predicted to results in an asymptotic curve, where initial repetitions in behaviour result in greater increases in automaticity until the automaticity level plateaus (Lally et al., 2010; Hull, 1951; Hull, 1943). Therefore automaticity data was to be plotted to see if this curve was evident.

6.4.10.2.2 Interview analysis

Similar to study 2 (a qualitative study to identify the nature of tooth brushing behaviour), data from the interviews conducted at follow-up was to be analysed using the framework methods of thematic analysis (Gale et al., 2013). NVIVO was to be used to support data analysis with codes applied to the data in an inductive manner and subsequently grouped together to form relevant emerging categories.

6.4.11 Results

Recruitment was attempted from all three sites (Liverpool Women's NHS Foundation Hospital, Five Children's Centre in Speke, Liverpool and May Logan Healthy Living Centre in Bootle, Liverpool). 'Booking' appointments were allocated an hour slot for each patient, with a maximum of three patients per morning or afternoon session per midwife. Within the community clinics, only one 'booking' clinic ran on selected days during the week, and field notes reported cancellation of clinics was common. This was either due to staff sickness or 'clinic cancelled'. Table 6.6 shows an example of the recruitment log from one for the 3 recruitment sites.

Unfortunately, over a three month period, only one participant was considered eligible to participate. After arranging to conduct the intervention delivery with her at her follow-up appointment (participant was advised to come back for an ultrasound scan later in the day), it was discovered that she unfortunately had a non-viable pregnancy. She was understandably unwilling to participate and was therefore excluded.

Table 6.6 Recruitment Log Five Children's Centre, Speke, Liverpool

Monday 04 December 2017

	Recruited (R) / Not Recruited (NR)	Reason for not recruiting
Patient 1	NR	Brush twice daily Registered nurse
Patient 2	NR	Brush twice daily Second pregnancy
Patient 3	NR	Brush twice daily

No afternoon session booked

Monday 11 December 2017

	Recruited (R) / Not Recruited (NR)	Reason for not recruiting
Morning session		
Patient 1	NR	Brush twice daily
Patient 2	NR	Brush twice daily
Patient 3	NR	Brush twice daily Limited time to fully discuss oral hygiene behaviours with participant
Afternoon session		
Patient 4	NR	Brush twice daily
Patient 5	NR	Brush twice daily
Patient 6	NR	Brush twice daily Third pregnancy

Monday 18 December 2017

	Recruited (R) / Not Recruited (NR)	Reason for not recruiting
Morning session		
Patient 1	NR	Brush twice daily Currently wearing fixed orthodontic appliance so brushing is especially important to her at the moment
Patient 2	NR	Brush twice daily
Patient 3	NR	Brush twice daily
Afternoon session		
Patient 4	NR	Brush twice daily
Patient 5	NR	Cancelled

Monday 08 January 2018

	Recruited (R) / Not Recruited (NR)	Reason for not recruiting
Morning session		
Patient 1	NR	Brush twice daily
Patient 2	NR	Brush twice daily
Patient 3	NR	Brush twice daily

No afternoon session booked

As is evidenced by the log, the main reason for being unable to recruit to the study was the lack of participants reporting a tooth brushing frequency of less than twice daily. Interestingly, however, this was not an issue identified within Study A, where recruitment of participants was completed. Therefore, because this study was unable to be recruited to, the decision was made to stop recruitment and to reconsider future direction.

6.4.12 Discussion

The aim of this study was to explore the potential of delivering a tooth brushing intervention based on habit formation within an antenatal setting. Based on the results from STAGE 1 of the study, it was decided to implement the intervention just before the 'booking' appointment, in an antenatal setting, delivered by the researcher.

Failure to recruit to the study criteria resulted in study closure. Whilst this is an undesirable outcome, it is important to report these findings to ensure the knowledge gained is not futile and helps against publication bias (Kicinski, 2014).

Studies have reported self-reported tooth brushing frequency as an appropriate proxy measure for oral hygiene in adolescents (Gil et al., 2015) and measuring tooth brushing behaviour by data logging (Zillmer, 2013), however, these do not address the issues raised within this study. Query has been raised as to whether the self-report eligibility question was appropriate for this group. There appears to be a heavy pressure on social acceptability of responses given they were about to become mothers. Indeed, this was one of the findings from the focus groups (section 6.3.7.3),

where consideration was given to the social judgement and desire of mothers to appear to perform social norms. Perhaps, as all participants were happy to complete screening questions by the researcher, one way around this issue of response bias would be to determine the automaticity levels of an individual's tooth brushing behaviour by using the SRBAI (self-reported behavioural automaticity index) tool. This would indicate an individual's strong or weak habit for tooth brushing behaviour. A value of 8 or less could be considered a weak habit (Gardner et al., 2012) and therefore substitute tooth brushing frequency for inclusion. However, this would require further exploration, as the possibility remain that certain individuals consistently repeated behaviour yet this remains cognitively processed.

Perhaps another approach to aid recruitment, especially within hard-to-reach populations, would have been to involve community champions within the study to deliver the intervention. Community champions are individuals identified within the target community who have the respected and understanding of the target community. For example, Clarke (2007) empowered thirteen community champions (which they termed "Community Health Advisors (CHAs)") to disseminate oral health information to their communities via their chosen methods, including presentations at community gatherings (e.g. church), discussion of oral health with friends, family and neighbours and constructing and distributing holiday cards with oral health information. Results showed CHA to be successful at influencing the community attitudes towards dental visits. Perhaps this approach could be taken for the delivery of the intervention within this study as it potentially overcome the social acceptability issue as individuals may report their tooth brushing frequency with more accuracy to trusted peers within the community.

6.4.13 Conclusion

Overall, this study helps to understand the limitations of conducting a tooth brushing intervention within an antenatal setting with recruitment to the inclusion criteria being the biggest problem. Suggestions, such as using the SRBAI for inclusion instead of self-report of behaviour, are made. However, these require more exploration and validation.

Chapter 7: Concluding discussion and conclusions

7.1 Overview

At the outset of this thesis four research questions were set, namely:

1. Do cue-automaticity interventions have a place in preventive healthcare for adults?
2. Could these types of interventions (cue-automaticity) translate into the dental context?
3. What is the nature (habitual/automatic or cognitive/considered) of tooth brushing behaviour?
4. If tooth brushing behaviour is habitual, can a habitual tooth brushing intervention be developed and delivered?

This chapter will draw together the findings from this body of work to help answer the above research questions. Following this, a section will document what this thesis contributes to the literature with reflections of practice. Finally, concluding remarks along with recommendations for practice and future research conclude the chapter.

7.2 Do cue-automaticity interventions have a place in preventive healthcare for adults?

The systematic review (chapter 3) explored how previous interventions containing a component of cue-automaticity aimed to improve the uptake of preventive healthcare. Only six studies were included within the review and all incorporated Implementation Intentions (II) as at least part of the intervention tool. Five of six included studies showed a significant effect with the intervention increasing preventive healthcare use (for vaccinations and cancer screening services),

suggesting that whilst this area of research may be relatively new and unexplored, it may offer an effective way to improve preventive health care service uptake.

In the review, behavioural intention was the only significant variable associated with intervention effectiveness. This is in keeping with the habit theory proposed, that intention to perform the behaviour is the first 'step' in establishing habitual behaviour (Lally & Gardner, 2013; Gardner, Lally & Wardle, 2012) (see literature review chapter, section 2.8.2). Intention can be seen as an indicator of motivation which underlies it's importance as a pre-requisite in this type of intervention (Michie et al., 2011).

Therefore, when consideration is given to the development of future interventions targeted towards increasing the uptake of preventive healthcare services, a focus should be on the importance of intention to attend preventive healthcare appointments within the intervention.

7.3 Could these types of interventions (cue-automaticity) translate into the dental context for adults?

To apply the findings from study 1 (chapter 3) into the dental context, exploration was conducted to determine how this type of intervention could be applied to the dental context for infrequent behaviours (i.e. preventive dental visiting). Evidence suggests that the completion of an II intervention aimed at increasing dental check-up attendance might be most effective when it documents where (i.e. which dental practice you will contact), when (i.e. which date and time you will contact with the dental practice) and how (i.e. telephone / email /face-to-face) patients will make an

appointment, rather than designing the intervention around overcoming barriers (such as arranging time off work) for dental attendance. In addition, the importance of full completion of the II should be highlighted to ensure maximum effectiveness, at this was one of the key findings from the systematic review.

To date, there are seven cue-automaticity interventions in adults which solely focus on establishing flossing behaviour. Six of the interventions most commonly used a component of II (Orbell & Verplanken, 2010 Study 3; Schüz et al., 2009; Åstrøm, 2008; Sniehotta, Araújo Soares & Dombrowski, 2007; Schüz et al., 2006; Lavin & Groarke, 2005). A further study also used eliciting personalised routines to identify individualised cues as the behavioural change technique (Judah, Gardner & Aunger, 2013). Participants in this study were students and individuals from the Psychology and Language subject pool, and so, although novel, was somewhat removed from application as a one-to-one health intervention. Of these seven studies, only two focused the interventions on establishing automatic flossing behaviour (Orbell & Verplanken, 2010; Judah, Gardner & Aunger, 2013) with the remaining five studies considering the intervention through the lens of closing the intention-behaviour gap (Sheeran, 2002), with measurements of automaticity not included at either baseline or follow-up. Of the two studies which measured the automaticity of behaviour following delivery of the intervention, both resulted in a positive establishment of automaticity of behaviour at 8 weeks (Orbell & Verplanken, 2010) and 8 months (Judah, Gardner & Aunger, 2013).

Again, these findings speak to the relatively novel application of this theory-based research approach to the dental context. However, initial studies suggest the

application of habit theory to the dental context could be effective, especially since previous work suggests there are benefits for long term behaviour maintenance (Rothman, Sheeran & Wood, 2009; Rothman, 2000) when motivation and intention may wane (Neal, Wood, Wu & Kurlander, 2011; Lally, Wardle & Gardner, 2011). A note of caution however, both previous interventional studies involving long term follow up of automaticity of behaviour involved participants who were students or members of the public held within the Psychology and Language subject pool (Judah, Gardner & Auger, 2013). This means that a research gap remains since at the outset of the thesis no previous work had been done to explore the potential application of cue-automaticity interventions with harder to reach populations. Findings from Chapter 6 (study 4A) show that the approach does indeed have potential applicability in this context, however as shown in Chapter 6 Study 4B, intervention recruitment from hard-to-reach groups into empirical work relating to self-care interventions poses an additional challenge with longer term follow up posing further challenges.

7.4 To explore the nature of tooth brushing behaviour

Whilst the systematic review completed the understanding of the literature around habitual behaviour, both in terms of frequently performed (Gardner, 2015) and infrequently performed behaviours (Raison, Corcoran & Harris, 2017), the decision was made to explore tooth brushing behaviour further as this had received very little research attention previously, even though increasing tooth brushing with a fluoride toothpaste is one of the key means by which oral health is improved (dos Santos, Ndanovsky & de Oliveira, 2013; Frencken et al., 2012; Buzzalaf et al., 2011; Wong et al., 2011). In contract, evidence of the benefits of flossing behaviour show that

whilst there is some reduction in periodontal disease, the effect upon dental caries reduction is debateable and requires further exploration (Poklepovic et al., 2013; Sambunjak et al., 2011). Moreover, tooth brushing is considered a simple and frequently performed behaviour, and because of this, could perhaps benefit most from the application of habitual theory. Therefore the focus of the remaining chapter of this thesis was on applying the habit lens to tooth brushing behaviour.

According to the dual processing model, behaviour is considered to occur through two different processes: System 1 and System 2 (Evans & Stanovich, 2013). As discussed within the literature review chapter (section 2.8), System 1 is considered to be unconscious, impulsive, automatic and adaptive unconscious in comparison to System 2 which is reflective, controlled and conscious (Hofmann, Friese & Wiers, 2008; Strack & Deutsch, 2004; Evans, 2003). Therefore, tooth brushing behaviour could be considered to occur either as an automatic, habitual process or via a reflective, conscious process. Indeed, the instigation (*'deciding to brush'*) and/or execution (*'performing tooth brushing'*) could each be conducted in either a habitual or cognitive manner (Phillips & Gardner, 2016; Verplanken & Melkevik, 2008). And whilst the literature proposes the constant repetition of tooth brushing behaviour will lead to habit formation (Newton & Asimakopoulou, 2017; Innes & Manton, 2017), exploration of the true nature of established tooth brushing behaviour concept was mainly a theoretical proposition prior to this body of work.

Study 2 (qualitative study to explore the nature of tooth brushing behaviour) began to speak to this research question. Via in-depth semi-structured interviews, with individuals who brushed their teeth regularly, the nature of their tooth brushing

behaviour was explored. The findings from analysis offer, for the first time, empirical evidence to the habitual nature of tooth brushing behaviour. In addition to this, the cross-sectional survey (study 3, chapter 5) offered further empirical evidence of the habitual nature of tooth brushing with over 80.6% of participants reporting high levels of automaticity (scores of 17-20 on the self-reported behavioural automaticity index) for tooth brushing behaviour.

Both study 2 & 3 (chapters 4 & 5 respectively) start to discuss the need to start to consider tooth brushing behaviour in the morning as distinctly different to the evening, an important finding when considering the design of future habitual tooth brushing interventions. The distinct differences in cues to initiate behaviour and motivators to drive the behaviour repetition identified within the in-depth interventions (study 2, chapter 4), and the statistically significantly higher automaticity scores for morning tooth brushing compared to evening tooth brushing (study 3, chapter 5), suggests that variance in evening routines results in missed opportunities to brush their teeth leads to less automatic behaviour. Although occasional lapses (missing one day but performing the behaviour before and after the omission) in behaviour have been shown to not significantly hinder habit formation (Lally et al, 2010), other studies have shown that longer lapses in behaviour do negatively affect future conduct of behaviour (Armitage, 2005).

Whilst with some simple actions (such as turning on a light switch), determining a discreet difference between deciding and performing behaviour is difficult (Gardner, 2015), tooth brushing behaviour can be divided into instigation (*'deciding to brush')* and execution (*'performing tooth brushing').* A recent habitual exercise study

(Phillips & Gardner, 2016), recruited 124 students and facility members, and asked them to complete baseline and 1 month follow-up self-reported behavioural automaticity scores for the exercise they were encouraged to perform twice a week for 20 minutes. Results showed habit instigation was more important than habitual execution for long term maintenance of frequent behaviours and better predicts behaviour frequency (Phillips & Gardner, 2016). Within the dental context, this is important as, according to the findings reported in chapter 5, tooth brushing behaviour appears to be more habitually instigated than conducted. This implied that behavioural maintenance over the long term is more likely to be maintained. It also suggests that more cognitive effort goes into the performance of tooth brushing which may be advantageous for most effective brushing.

7.5 If tooth brushing behaviour is habitual, can a habitual tooth brushing intervention be developed and delivered?

Study 4 (chapter 6) explored the development and delivery of a habitual intervention. As discussed within the literature review chapter (section 2.2), a number of different behavioural change theories are widely acknowledged including The Theory of Planned Behaviour (Ajzen, 2011), Transtheoretical or stages of change model (Prochaska & DiClemente, 1983; Prochaska, DiClemente, & Norcross, 1992) and the Health Belief Model (Becker, 1974; Rosenstock, 1966). NICE guidelines recommend that taking a theoretical approach to oral health intervention development offers the most promising approach to the design of effective interventions (NICE, 2015). However habit formation theory is almost completely absent from the design of interventions in dentistry, and so this thesis significantly contributes to addressing this gap.

One of the most widely accepted behavioural change models currently used is the COM-B model (Figure 2.3). This identifies that Capability, Opportunity and Motivation are all critical precursors for behaviour change. The thesis therefore supports the recognition of the COM-B model use alongside habit formation theoretical approaches. This is because to form a tooth brushing behaviour, individuals are required to be sufficiently motivated to brush their teeth, capable of completing the behaviour and having the opportunity to repeat the tooth brushing behaviour in a stable context until it become habitual (Lally & Gardner, 2013). However, after tooth brushing has become automatic, behaviour instigation becomes governed by non-conscious, automatic, system 1 processes, which will remain dominant even when motivation and intention wane (Neal et al., 2011; Lally, Wardle & Gardner, 2011; Rothman, 2000). In this respect, the habit formation approach builds on traditional models of behaviour change (synthesised into the 'COM-B' (capability, opportunity, motivation, behaviour) framework (Michie et al, 2011)), but adds the concept of 'context-dependent repetition', which develops habit associations (Lally et al., 2010). The thesis supports this by identifying that intention is an important predictor of preventive visiting (Study 1), and self-efficacy (capability) is an important predictor for self-reported automaticity levels for tooth brushing behaviour (study 3).

The thesis incorporated some intervention development work involving people who have varying or flexible routines (chapter 6, study 4A), as study 2 & 3 (chapters 4 & 5 respectively) discuss as a findings the lack of routines in the evening possibility leading to a reduced self-reported behavioural automaticity for behaviour instigation. Whilst recruited participants all had varying routines (i.e. variable work shifts), all

were able to identify a single salient cue to initiate tooth brushing behaviour. In addition, it demonstrated that this type of intervention is acceptable to members of the public and is shown to be a quick, personalised one-to-one intervention which perhaps can establish twice daily habitual tooth brushing behaviour.

Leading on from this work, barriers to the delivery of a tooth brushing intervention within an antenatal setting were experienced due to difficulty to recruit to the inclusion criteria. Social acceptability for new mothers may be high during ante-natal visits, where documentation of behaviours may be influenced by social norms. For example, underreporting alcohol consumption during pregnant has been documented as a result of 'fear of judgement' (Muggli et al., 2015), whilst other studies have shown pregnant woman felt under pressure to report themselves as non-smokers when questioned within the ante-natal setting (Graham & Owen, 2003). This is also evident when self-reporting taking vitamins as well (McGowan & McAuliffe, 2012). Therefore, new methods to overcome these barriers are required.

7.6 Thesis contribution and reflections

7.6.1 Study 1: Systematic review

The systematic review conducted within study 1 adds evidence to the effectiveness of cue-automaticity interventions to increase the uptake of preventive healthcare (vaccinations and cancer screening). It appropriately provides an evidence based answer by synthesising all available evidence together to conclude that while such interventions are rare (six in total), they appear to be effective in increasing the uptake of infrequent healthcare behaviours. A paper in a peer-reviewed journal is appended (Appendix 1).

7.6.2 Study 2: Qualitative study on the nature of tooth brushing behaviour

This research study adds empirical evidence to the theoretically speculated assumption that tooth brushing behaviour is habitual in nature. It adds to the literature by suggesting the need to begin to consider tooth brushing behaviour in the morning as different from that conducted in the evening, due to different cue and motivators that drive the habitual process.

Having reflected on the study conducted, perhaps it may have been advantageous to collect data from participants from a range of settings rather than just one centre. On the other hand, data saturation was reached, and a wide range of participants, age, gender and socio-demographic grouping were included in the study. This qualitative study, the first of its type, provided some important, new evidence about the elements which underpins tooth brushing behaviour.

7.6.3 Study 3: Cross-sectional survey to explore the automaticity of oral health behaviours

Again, this study adds empirical evidence to the literature on the habitual nature of tooth brushing behaviour. In addition, the survey reports age, gender and self-efficacy to statistically significantly influence the level of self-reported automaticity for tooth brushing behaviour reported. It adds preliminary data on the spread of automaticity of tooth brushing behaviours, and would enable power calculations for interventional studies to be undertaken.

Having reflected on the study and its findings, a higher prevalence of twice-daily tooth-brushers (82.7%) within our participant group may reflect our recruitment

methods involving adults attending the dentist rather than, for example, at home (although recruiting in part from an urgent dental care setting was intended in part to offset this). Alternatively, the higher prevalence of reported tooth brushing frequency might have been a result of a sample bias.

7.6.4 Study 4: Tooth brushing intervention development in vulnerable populations

Applying a habitual tooth brushing intervention appears promising. The intervention delivered to members of the public was quick and personalised, with good acceptability. However, when applying to the ante-natal setting, the high levels of self-reported twice daily tooth brushing resulted in study closure due to failure to recruit.

Having reflected on study 4A, perhaps a further extension would be to include a longer term follow-up of participants to measure levels of automaticity for the new tooth brushing behaviour and therefore determine levels of habitual behaviour formed. Reflections also on study 4B (intervention delivery in an ante-natal setting), identified social acceptability as possibly the main driver for the higher than expected self-reported behaviour; an alternative for inclusion criteria may assist future interventions. Perhaps, one way around this issue of response bias would be to determine the automaticity levels of an individual's tooth brushing behaviour by using the SRBAI (self-reported behavioural automaticity index) tool. This would indicate an individual's strong or weak habit for tooth brushing behaviour. A value of 8 or less could be considered a weak habit (Gardner et al., 2012) and therefore substitute tooth brushing frequency for inclusion. However, this would require

further exploration, as the possibility remains that certain individuals may consistently repeat behaviour but remains cognitively processed.

7.7 Summary of conclusions

- Cue-automaticity interventions to increase preventive healthcare uptake are a relatively new and an unexplored area of research but have promising initial results.
- Application of cue-automaticity interventions to the dental context might be most effective when it documents where (i.e. which dental practice you will contact), when (i.e. which date and time you will contact with the dental practice) and how (i.e. telephone / email /face-to-face) patients will make an appointment.
- Tooth brushing behaviour is habitual with higher levels of automaticity noted for instigation than execution and for morning than evening tooth brushing.
- Participant variables such as age, gender and self-efficacy are associated with the level of self-reported automaticity.
- Initial development of a habitual tooth brushing intervention, using post-it notes to identify salient individualised cues, appears to be well-accepted, personalised and quick.
- Implementing the delivery of a habitual tooth brushing intervention within the ante-natal care setting requires further work to overcome higher levels of self-reported tooth brushing behaviour possibly due to high level of social acceptability.

7.8 Recommendations for practice

- Tooth brushing behaviour has been demonstrated to be instigated and executed in a habitual manner from studies 2, 3 & 4. Therefore, dentists could aim to implement this brief intervention should a patient appear to be adequately motivated and to report brushing only once a day (or less). It would serve as a brief one-to-one intervention which may help to increase tooth brushing behaviour, and importantly, establish it as habitual and therefore sustain tooth brushing even when motivation wanes.
- Oral health information for pregnant women is an area which needs to be addressed. Study 4B demonstrated via the focus group, that delivery of basic information, such as the importance of twice daily tooth brushing and visiting the dentist, within the ante-natal care appointments is missing. Therefore, one recommendation for practice would be to ensure that professionals from ante-natal care settings provide information around oral health, particularly to individuals from low socio-economic status (SES), as this is an area which has a significant gap at present.
- In addition, in order to help address the oral health inequalities experienced, consideration could be given to the distribution of oral hygiene products (such as a tooth brush, toothpaste and possibly interdental cleaning products) alongside the delivery of oral health information, to individuals living within the most deprived areas. This may encourage engagement of oral hygiene practices, such as twice daily tooth brushing or flossing, and therefore have an impact upon oral health inequalities.

7.9 Recommendations for future research

- The systematic review showed the positive effect that a cue-automaticity intervention (interventions which contain a component incorporating an II) on the uptake of preventive healthcare services. Therefore, one future recommendation for research would be to explore if the same intervention effect could be achieved in relation to preventive dental care attendance. The next step would be to develop an intervention based on this approach and subsequently test to see if this type of intervention results in an increase in dental attendance over the longer term.
- Exploration is required to determine where a habitual tooth brushing intervention to establish twice daily, habitual tooth brushing would best be delivered. Possible context options may include 'the workplace' either through anonymised email recruitment (Milkman et al., 2011) where completion of the post-it note activity and subsequent IIoccurs online or at the gym, where participants are already motivated towards general health. These contexts may perhaps be more suitable as being away from a clinical environment may encourage a more honest response to the frequency of tooth brushing behaviour question and therefore attract larger number of participants for inclusion. However, these methods are not without their limitations and this would have to be explored prior to conduct.

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Appendices

Appendix 1. MEDLINE (Ovid) electronic search strategy

	Searches	**Results**
1	habit*.tw.	113144
2	Habits/	2832
3	(habit* adj3 behavio?r).tw.	1145
4	cue*.tw.	60237
5	((context* or situat*) adj3 cue*).tw.	1994
6	automatic*.tw.	71196
7	((intrinsic* or extrinsic*) adj3 reward*).tw.	285
8	routin*.tw.	268559
9	Cues/	27763
10	(lack* adj2 aware*).tw.	2757
11	(unintention* or uncontroll* or unconscious* or undeliberat* or repeat*).tw.	444482
12	"Unconscious (Psychology)"/	3087
13	Reward/	13145
14	reward*.tw.	34190
15	(implement* adj3 intent*).tw.	398
16	intention/	6594
17	(repeat* adj4 behavio?r).tw.	868
18	((initiat* or learn* or stabilit*) adj phase*).tw.	1930
19	(action* adj3 plan*).tw.	7152
20	or/1-19	991509
21	"Patient Acceptance of Health Care"/	31499
22	(health* adj3 (maint* or behavio?r)).tw.	28394
23	Health Behavior/	34829
24	(preventat* adj1 visit*).tw.	1
25	(vaccinat* adj3 (attend* or appoint* or uptake*)).tw.	713
26	Vaccination/	56080
27	Mass Screening/	82789
28	(screen* adj3 (mass or program*)).tw.	28082
29	Mammography/	24296
30	(breast* adj1 cancer adj1 screen*).tw.	4131
31	(mammogra* adj3 (attend* or uptake* or appoint*)).tw.	282
32	Vaginal Smears/	19780
33	((cervical* or vagin*) adj3 cancer adj3 (screen* or test*)).tw.	5405
34	(smear adj2 (test* or screen*)).tw.	1747
35	(("blood pressure*" or cholesterol*) adj2 (examin* or screen* or check* or check?up or appoint* or test* or assess*)).tw.	6289
36	((dental* or dentist*) adj2 (examin* or screen* or check* or check?up or appoint* or test* or assess*)).tw.	6467
37	Dental Care/	15489
38	((eye* or sight*) adj3 (examin* or screen* or check* or check?up or appoint*	14624

	or test* or assess*)).tw.	
39	((Asymptomat* or regular* or routine*) adj4 (visit* or attend* or appoint*)).tw.	7270
40	"Early Detection of Cancer"/	9136
41	(prevent* adj cancer* adj3 (screen* or attend*)).tw.	43
42	(prevent* adj health* adj2 (use* or utilisat*)).tw.	186
43	or/21-42	321722
44	20 and 43	31937
45	randomized controlled trial.pt.	384261
46	randomized controlled trial/	384261
47	controlled clinical trial.pt.	88599
48	controlled clinical trial/	88599
49	randomized controlled trials as topic/	95378
50	random allocation/	81919
51	double blind method/	127422
52	single blind method/	19812
53	Quasi RCT.tw.	41
54	feasibility studies/ or pilot projects/	125656
55	controlled RCT.tw.	50
56	cluster analysis/	43516
57	experiment* stud*.tw.	76728
58	feasibil* stud*.tw.	8256
59	pilot project*.tw.	3717
60	cluster* randomi* trial*.tw.	1854
61	intervention studies/	7258
62	or/45-61	865423
63	44 and 62	3571
64	(exp Child/ or Adolescent/ or exp Infant/) not exp Adult/	1531448
65	63 not 64	**2999**

Appendix 2. Forward and backward citation documentation

Paper	Forward Citation searching	Backward citation searching
Vet et al, 2014	Not currently cited elsewhere	3 relevant papers • References; 20, 21 & 22, 29 • Already included within the review: ref 21. • Exclude: 20, 22. And 29 Intervention not targeted towards preventive healthcare service utilisation
Sheeran et al, 2000	334 citations 23 considered possibly relevant after title screening 1. Intention—behavior relations: A conceptual and empirical review P Sheeran - European review of social psychology, 2002 - Taylor & Francis Exclude – theoretical paper. 2. Implementation intentions and goal achievement: A meta-analysis of effects and processes PM Gollwitzer, P Sheeran - Advances in experimental social psychology, 2006 – Elsevier Exclude – Interventions not targeted towards preventive healthcare service utilisatiob 3. Combining motivational and volitional interventions to promote exercise participation: Protection motivation theory and implementation intentions S Milne, S Orbell, P Sheeran - British journal of health …, 2002 - Wiley Online Library Exclude – Intervention not targeted towards preventive healthcare service utilisation 4. Evidence that implementation intentions reduce dietary fat intake: a randomized trial. CJ Armitage - Health Psychology, 2004 - psycnet.apa.org Exclude – Intervention not targeted towards preventive healthcare service utilisation 5. Mechanisms of implementation intention effects: the role of goal intentions, self-efficacy, and accessibility of plan components TL Webb, P Sheeran - British Journal of Social Psychology, 2008 - Wiley Online Library	4 relevant papers • References: Milne et al, 1999; Orbell et al, 1997; Sheeran et al, 1999 (Implementation intentioons and repeated behaviour …) Verplanken et al, 1999. • Exclude all. Intervention not targeted towards preventive healthcare service utilisation

	Exclude – Intervention not targeted towards preventive healthcare service utilisation 6. The use of implementation intentions and the decision balance sheet in promoting exercise behaviour A Prestwich, R Lawton, M Conner - Psychology and Health, 2003 - Taylor & Francis Exclude – Intervention not targeted towards preventive healthcare service utilisation 7. Identifying good opportunities to act: Implementation intentions and cue discrimination TL Webb, P Sheeran - European Journal of Social Psychology, 2004 - researchgate.net Exclude – Intervention not targeted towards preventive healthcare service utilisation 8. Breaking and creating habits on the working floor: A field-experiment on the power of implementation intentions RW Holland, H Aarts, D Langendam - Journal of Experimental Social …, 2006 – Elsevier Exclude – Intervention not targeted towards preventive healthcare service utilisation 9. From Intentions to Behavior: Implementation Intention, Commitment, and Conscientiousness1 I Ajzen, C Czasch, MG Flood - Journal of Applied Social …, 2009 - Wiley Online Library Exclude – Intervention not targeted towards preventive healthcare service utilisation 10. The automatic component of habit in health behavior: habit as cue-contingent automaticity. S Orbell, B Verplanken - Health Psychology, 2010 - psycnet.apa.org Exclude – Intervention not targeted towards preventive healthcare service utilisation 11. Action control by implementation intentions: Effective cue detection and efficient response initiation EJ Parks-Stamm, PM Gollwitzer, G Oettingen - Social Cognition, 2007 - Guilford Press Exclude – Intervention not targeted towards preventive healthcare service utilisation	

	12. An implementation intentions intervention to increase uptake of mammography DR Rutter, L Steadman, L Quine - Annals of Behavioral Medicine, 2006 – Springer Already included within the review 13. Using implementation intentions prompts to enhance influenza vaccination rates KL Milkman, J Beshears, JJ Choi… - Proceedings of the …, 2011 - National Acad Sciences Already included within the review 14. Implementation intention and action planning interventions in health contexts: State of the research and proposals for the way forward MS Hagger, A Luszczynska - Applied Psychology: Health and …, 2014 - Wiley Online Library Exclude – Interventions do not include increasing healthcare service utilisation 15. Decision counseling in cancer prevention and control. RE Myers - Health Psychology, 2005 - psycnet.apa.org Exclude – Intervention does not contain a habit formation component 16. Using the Health Action Process Approach and implementation intentions to increase flu vaccine uptake in high risk Thai individuals: A controlled before-after trial. Y Payaprom, P Bennett, E Alabaster… - Health …, 2011 - psycnet.apa.org INCLUDE 17. Using the theory of planned behaviour to predict screening uptake in two contexts S Michie, E Dormandy, DP French… - Psychology & …, 2004 - Taylor & Francis Exclude – Interventions do not include increasing healthcare service utilisation 18. From the bench to public health: population-level implementation intentions in colorectal cancer screening E Neter, N Stein, O Barnett-Griness, G Rennert… - American journal of …, 2014 – Elsevier Already included within the review	

	19. Turning intention into behaviour: The effect of providing cues to action on participation rates for colorectal cancer screening I Flight, C Wilson, J McGillivray - 2012 - intechopen.com Exclude – although this is a good paper, there is no specific mention of behaviour becoming automatic, although it does mention the fact that behaviour is initiated by a 'cue'. 20. Increasing attendance at breast cancer screening: Field trial D Rutter, L Quine, L Steadman… - Final report. University of …, 2007 - screening.org.uk Exclude: Intervention not based on habit formation theory 21. Implementation intentions and colorectal screening: a randomized trial in safety-net clinics KA Greiner, CM Daley, A Epp, A James, HW Yeh… - American journal of …, 2014 – Elsevier Already included within the review 22. Implementation intention and action MS Hagger, A Luszczynska - 2014 - researchgate.net Exclude – Intervention not based on habit formation theory 23. The role of implementation intention formation in promoting hepatitis B vaccination uptake among men who have sex with men R Vet, JBF de Wit, E Das - International journal of STD & AIDS, 2014 - std.sagepub.com# Already included within the review	
Neter et al, 2014	7 citations Exclude All	16 relevant papers • References: 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 36, 37, 38 • Already included within the review: 25, 26, 38 • Exclude all remaining: Intervention not targeted towards preventive healthcare service utilisation
Rutter et al, 2006	62 citations 8 considered possibly relevant after title screening 1. Using implementation intentions prompts to enhance influenza vaccination rates KL Milkman, J Beshears, JJ Choi… - Proceedings of the …, 2011 - National Acad Sciences Already included within the review	13 relevant papers • References: 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 36 • Already included within the review: 28 • Exclude all remaining: Intervention not targeted towards preventive healthcare service utilisation •

	2. Implementation intention and action planning interventions in health contexts: State of the research and proposals for the way forward MS Hagger, A Luszczynska - Applied Psychology: Health and …, 2014 - Wiley Online Library Exclude – Interventions do not include increasing healthcare service utilisation 3. How can the impact of implementation intentions as a behaviour change intervention be improved? A Prestwich, I Kellar - … de Psychologie Appliquée/European Review of …, 2014 – Elsevier Exclude – Interventions do not include increasing healthcare service utilisation 4. From the bench to public health: population-level implementation intentions in colorectal cancer screening E Neter, N Stein, O Barnett-Griness, G Rennert… - American journal of …, 2014 – Elsevier Already included within the review 5. Turning intention into behaviour: The effect of providing cues to action on participation rates for colorectal cancer screening I Flight, C Wilson, J McGillivray - 2012 - intechopen.com Exclude – although this is a good paper, there is no specific mention of behaviour becoming automatic, although it does mention the fact that behaviour is initiated by a 'cue'. 6. Increasing attendance at breast cancer screening: Field trial D Rutter, L Quine, L Steadman… - Final report. University of …, 2007 - screening.org.uk Exclude: Intervention not based on habit formation theory 7. Implementation intentions and colorectal screening: a randomized trial in safety-net clinics KA Greiner, CM Daley, A Epp, A James, HW Yeh… - American journal of …, 2014 – Elsevier Already included within the review 8. Implementation intention and action MS Hagger, A Luszczynska - 2014 - researchgate.net Exclude – Intervention not based on habit formation theory	
Milkman et al, 2011	59 citations 4 considered possibility relevant after title screening	8 relevant papers • References: 17, 18, 19, 22, 23, 24, 25, 28

	1. Implementation intention and action planning interventions in health contexts: State of the research and proposals for the way forward MS Hagger, A Luszczynska - Applied Psychology: Health and …, 2014 - Wiley Online Library Exclude – Interventions do not include increasing healthcare service utilisation 2. From the bench to public health: population-level implementation intentions in colorectal cancer screening E Neter, N Stein, O Barnett-Griness, G Rennert… - American journal of …, 2014 – Elsevier Already included within the review 3. Effectiveness of worksite interventions to increase influenza vaccination rates among employees and families CL Ofstead, BW Sherman, HP Wetzler… - … of Occupational and …, 2013 - journals.lww.com Exclude – Intervention not based on habit formation theory 4. Implementation intention and action MS Hagger, A Luszczynska - 2014 - researchgate.net Exclude – Intervention not based on habit formation theory	• Already included within the review: 25, 28 • Exclude all remaining: Intervention not targeted towards preventive healthcare service utilisation
Greiner et al 2014	2 citations Exclude all	10 relevant papers • References: 11, 17, 29, 30, 32, 34, 35, 36, 37, 38, 39, 42, • Already included within the review: 36, 37 • Exclude 11, 17: Intervention doesn't contain a habitual component • Exclude 29, 30, 32, 34, 35, 36. Intervention not targeted towards preventive healthcare service utilisation • Exclude: 39 and 42. Not an intervention

Appendix 3. Published manuscript in Community Dental Health

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A systematic review of interventions using cue-automaticity to improve the uptake of preventive healthcare in adults: applications to dental visiting

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Objective: Since behaviour is underpinned by both cognitive and automatic processes, psychological interventions aiming to instigate or modify habitual behaviour (cue-automaticity interventions) offer an alternative to the more commonly used (mainly educational) strategies to increase preventive healthcare use. Theory suggests that low socio-economic (SES) groups are especially likely to benefit. Cue-automaticity describes how repetition of behaviour, initiated by a particular 'cue', in a constant context, leads to the automatic instigation and/or execution of behaviour. Our primary objective was to assess the effectiveness of cue-automaticity interventions to improve the uptake of adult preventive healthcare, and to consider how this might be applied to the design of interventions to promote preventive dental visiting. ***Basic research design***: An electronic search, with citation snowballing, of cue-automaticity interventions to influence adult preventive healthcare use was undertaken. ***Results***: Searching identified 11,888 titles and abstracts. Paper screening left 26 papers, of which 6 RCTs met the inclusion criteria. All 6 incorporated an Implementation Intention (I-I) component. Four studies involved cancer screening and 2 involved vaccination programmes. Five studies showed a significantly positive increase in preventive healthcare use, while one did not. ***Conclusions***: Whilst few studies using cue-automaticity to underpin the promotion of preventive care use have been undertaken, studies that do exist have promising results. As cue-automaticity interventions may be of particular benefit to low SES groups, research is needed to investigate whether cue-automaticity interventions can translate into reducing inequalities in attendance for dental check-ups.

Key words: Prevention, Oral health, Health promotion, Dental Visiting Habits

Introduction

Dual processing models of behaviour explain how behaviour is influenced by both cognitive and automatic processes (Evans, 2008; Hofmann *et al.*, 2008). This means that two alternative strategies can be taken when designing behaviour change interventions. One approach, which is the basis of most educational and psychological interventions, is to focus on altering cognition – for example increasing awareness of the benefits of receiving care (Dela Cruz *et al.*, 2012; Cilbulka *et al.*, 2011), or increasing awareness of their ability to undertake a task (self-efficacy) (Kakudate *et al.*, 2009; Persson *et al.*, 1998; Stewart *et al.*, 1996). An alternative is to focus on instigating or modifying behaviour that is performed automatically (or impulsively); an approach which sits within the habit formation theory literature (Lally & Gardner, 2013; Gardner, 2015; Lally *et al.*, 2010; Gardner *et al.*, 2012; Aarts, Paulussen, Schaalma, 1997). A recent empirical review of habit-theory-based interventions showed promising results (Gardner, 2015), but was limited to relatively frequently undertaken behaviours such as exercise and healthy eating. Whether habit-theory based interventions are similarly effective in improving preventive health service use (which is a generally less frequent behaviour), has yet to be established.

Habits are defined as 'automatic behavioural responses to environmental cues, thought to develop through repetition of behaviour in consistent contexts' (Lally & Gardner, 2013) (Figure 1). Automaticity is considered to be a continuum, with the following four features; absence of deliberation, absence of awareness, absence of mental effort and absence of conscious control (Bargh et al, 1994). Cue-automaticity describes behaviour that automatically occurs when prompted by a particular cue (stimulus). The cue may be either external (for example: completing a preceding action in a sequence; seeing a visual prompt etc.), or internal (for example: a strong internal urge such as hunger). Indeed, internal cues may also be emotion-based such as anger or shame. Once experienced, such emotions may lead to automatic behaviour initiation and/or execution.

One way cue-automaticity may be established is by laying down an Implementation Intention (I-I). This involves identifying a pre-determined circumstance whence a particular behaviour will be enacted, and linking a cue to the behaviour through a statement such as: "*If situation x arises, then I will initiate the goal-directed response y*". The I-I (or 'if-then' plan) might be written down, visualised or verbalised – the important aspects being to heighten individual's awareness to the predetermined cue and establish a mental link between the specific cue and

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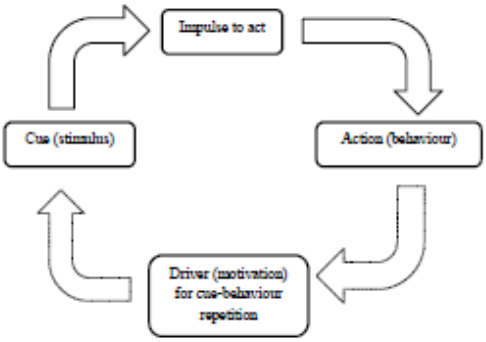

Fig 1. Cycle of stimulus and behaviour leading to habit formation

action (Webb & Sheeran, 2007; Gollwitzer & Sheeran, 2006; Webb & Sheeran, 2008). Through this mechanism, control for the performance of the behaviour is transferred from the self to the environment in the shape of the predetermined, personalised cue (Gollwitzer, 1999). Whilst sufficient motivation and cognition is required to undertake the thought processes involved in setting the I-I (Sheeran *et al.*, 2005), once the behaviour is carried out repeatedly according to the stipulated cue, behaviour gradually transfers from being cognitively enacted, to being automatic. The benefit of this, is that behaviour that is automatic is more likely to be maintained longer term, because when motivation wanes, the cue continues to prompt behaviour (Lally *et al.*, 2011; Rotham *et al.*, 2009). Although I-I are often used in intervention design as a means to establish habitual behaviours, habits can also be established without the use of this mechanism; for example, as a consequence of repeated, conscious, responses to particular cues (Lally et al, 2008).

Since studies show that living in poverty places such strains on internal resources that cognitive processing capacity is effectively reduced (Mani *et al.*, 2013; Mauraven & Baumeister, 2000), interventions that establish automatic behaviour may have benefits in addressing socio-economic related health inequalities. This is because automatic behaviour is relatively un-demanding of cognitive processes (Strack & Deutsch, 2004). In the context of interventions to promote early dental visiting, this is important, since those most in need of regular, preventive dental care are the least likely to take it up (Petersen *et al.*, 2005; Thomson *et al.*, 2010; Office of National Statistics, 2009; Petersen, 1990; Donaldson *et al.*, 2008; Watt, 2007). Lower rates of preventive dental visiting are found to account for at least some of the reduced level of oral health at the lower end of the SES visiting spectrum (Thomson *et al.*, 2010; Sanders *et al.*, 2006). Thus, interventions that promote preventive dental visiting are one way in which health inequalities may be reduced, and theoretically, cue-automaticity is designed type of intervention design which could offer particular benefits in this area.

Interest in the role of automatic behaviour in the instigation and maintenance of oral health behaviours is growing, most particularly in relation to promotion of daily flossing (Orbell & Verplanken, 2010; Judah *et al.*, 2013). A toothbrushing intervention study has also shown promising results (Wind *et al.*, 2005). The same approach has yet to be explored however, in relation to preventive dental visiting. Before we consider translating this approach to this third oral health behaviour, it is important to recognise that dental visiting is a much less frequent behaviour than either flossing or toothbrushing. This raises the question as to whether the use of cues to prompt dental visiting is sufficient to establish a pattern of habitual behaviour, given the extended timescales involved. To help answer this question, this paper reviews evidence from the wider healthcare context, and considers whether there is evidence that cue-automaticity interventions are effective for other similar types of preventive visiting behaviour such as attendance for cervical smears, examinations, eye tests etc. The paper also identifies the design features of these types of studies in order to help inform the design of cue-automaticity intervention in preventive dental visiting. The aim of our study was therefore two-fold: to assess the effectiveness of interventions containing a component of cue-automaticity aiming to improve the uptake of preventive healthcare (addressed in the results section), and to discuss how this approach might be applied to preventive dental visiting.

Methods

Study identification and selection criteria

Literature was identified by electronic searching, forward and backward citation searching and personal contact with experts in the field. A detailed search strategy was constructed using terms from key papers with each search strategy tailored to each of the eleven databases (details available in online appendix 1 and 2). Forward citation searching included screening all papers that cited the electronic searching inclusion papers, backward citation searching involved screened all papers cited within included papers identified from the electronic search.

One author screened all titles and abstracts. A sample of twenty per cent was screened by a second reviewer for agreement of exclusion/inclusion. Full paper versions of studies meeting the following inclusion criteria were retrieved to assess eligibility:

1. Design: Studies were limited to RCTs, quasi-RCTs, pilot studies, feasibility studies and cluster randomised trials of interventions aiming to improve the uptake of preventive healthcare services. Studies had to have a minimum of 8-10 weeks follow up (as literature suggests that a habit takes on average 66 days to form (Lally *et al.*, 2009)). Where data relating to follow up were not reported, authors were contacted to see whether they were available and if they could be obtained, the study was included. Studies were not restricted by language or publication date but were to primary data only. Inclusion criteria for health care services was any type of publicly or privately funded service that would benefit people's health. 'Preventive' was defined as services based on the principle of anticipatory action such as vaccination, health checks etc, where disease or ill health symptoms are not yet apparent.

2. Types of participants: Adults (aged 18 years or older) who were eligible for preventive healthcare services. We did not place any limitation by setting, and so interventions may have been undertaken in population (e.g. workplace) as well as health care settings.
3. Types of interventions: Only interventions that clearly linked the intervention to the production of automated behaviour (such as describing cue-automaticity associations) were included. Group (including family unit), community and individual interventions were all included. Each study had to have a control group (defined as a group that received standard preventive healthcare advice only) and/or an alternative intervention group.

Data extraction, data synthesis and quality assessment

The primary outcome was any type of attendance at a health service that was specifically for preventive purposes. Secondary outcomes included cognitive variables such as self-efficacy and measures of automatic behaviour. Data extraction was completed by a first assessor (HR) into structured data extraction tables and grouped according to the preventive healthcare service type (for example, cancer screening or vaccinations). Data extraction was double checked by a second assessor (SW), with any discrepancies resolved by a third assessor (RH). Due to the heterogeneity of studies ($Chi^2 = 23.64$, df = 6 (P=0.0006); $I^2 = 75\%$), data pooling i.e. meta-analysis was inappropriate. An assessment of risk of bias of included studies was completed using the Cochrane Tool (Higgins *et al.*, 2011) by two assessors (HR, SW). The overall quality of evidence was also assessed using the GRADE approach (Higgins *et al.*, 2011).

Results

Electronic searching, alongside backward and forward citations identified 11,888 titles and abstracts. Twenty six full papers were screened for eligibility of which twenty were excluded. Figure 2 is a PRISMA diagram with reasons for exclusion. The six RCTs included in the review were all published between 2000 and 2014. Included studies concerned either vaccinations (Hepatitis B (Vet *et al.*, 2014) and influenza (Milkman *et al.*, 2011) or cancer screening programmes (colorectal (Neter *et al.*, 2014; Greiner *et al.*, 2014), cervical (Sheeran & Orbell, 2000) and breast (Rutter *et al.*, 2006)). Length of follow up ranged from three to six months. One study did not report length of follow-up within the manuscript (Rutter *et al.*, 2006). However, clarification was achieved from the authors. Table 1 summarises the included studies.

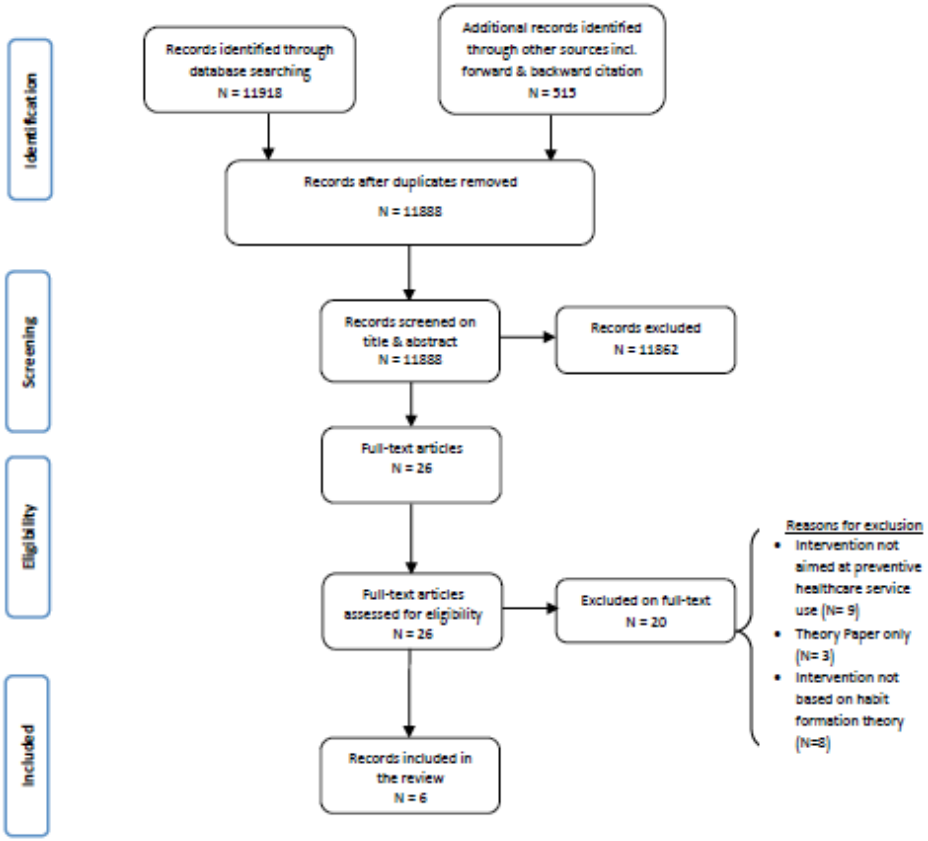

Figure 2. PRISMA diagram of study inclusion

...table 1 continued

Preventive healthcare service: Cancer screening

Greiner et al, 2014 USA n=470 Attendees at 9 safety-net clinics	Age 55 years (median) Gender 36.4% Male 63.6% Female Ethnicity /Race 27% Hispanic 42% Non-Hispanic African-American 28% Non-Hispanic white 3% Other	Inclusion Patients aged ≥ 50 years Have a provider visit on enrolment day Exclusion Income > 150% federal poverty level No home address No working phone Received faecal occult blood test of FIT in last year Sigmoidoscopy or barium enema in last 5y Colonoscopy in last 10y Acute medical illness Reported current GI bleeding History of colon polyps History of CRC First-degree relative with CRC before age 60y Inherited polyposis/non-polyposis syndrome Inflammatory bowel disease Another household member in study Cognitive impairment	Outcome Colorectal cancer screening – completion of either FIT or screening colonoscopy Baseline -PAPM staging -Perceived susceptibility to CRC -Self-efficacy for CRC screening -Cancer fatalism	Received info. & education on CRC screening. Completed I-I around CRC screening planning. Given print out of I-I Those "deciding to" pursue screening test were given either an FIT kit or colonoscopy scheduling info. & bowel prep materials before leaving clinic.	Received info. & education on CRC screening. Given questions and print out on diet, exercise & health living. Those "deciding to" pursue a screening test were given either an FIT kit or colonoscopy scheduling info. & bowel prep materials before leaving clinic	Touch-screen computer	Individuals who completed an I-I had higher odds of completing CRC screening than comparison (AOR=1.83). Higher self-efficacy were more likely to complete CRC screening (AOR=1.57)	I-I approach can contribute to successful completion of CRC screening even among very low-income & diverse primary care pop[r]

table 1 continued overleaf...

...table 1 continued

Neter et al, 2014 Israel n=27633 HMO-insured members	Age 62.31 years ± 6.66 (mean) Gender 43.8% Male 56.2% Female Ethnicity /Race N/R	Inclusion Performed FOBT test in last year No inflammatory bowel disease or malignancy No colonoscopy within previous 3 years Insured member	Outcome Colorectal cancer screening - completion of FOBT test Baseline -Intention -Perceived efficacy -CRC knowledge -Risk perception -Perceived health	Mailed FOBT kit & leaflet containing instructions to write down when, where & how to complete the FOBT test	Mailed info. leaflet & FOBT kit	Post	Individuals who completed an I-I were significantly more likely to complete FOBT testing than controls (unadjusted OR 1.18, 95% CI 1.12 to 1.24)	I-I technique is useful in increasing adherence to CRC screening, even in a mailed form rather than a face-to-face situation
Rutter et al, 2006 UK n=2082 Patients on NHSBSP screening database	Age 56.1 years (mean) Gender 100% Female Ethnicity /Race 98.6%White British	Inclusion Members of 2 screening cohorts from Kent, England Assessment-only Postal questionnaire measuring health behaviours, beliefs about attending for breast screening & details of their demographic background, prior to their invitation to screening.	Outcome Breast cancer screening – as recorded by screening centre Baseline -Intention -Beliefs -Subjective norm -Perceived behavioural control	Intervention Postal questionnaire measuring health behaviours, beliefs about attending for breast screening & demographic details. Also a section to formulate I-I to overcome 3 potential obstacles: Changing inconvenient appointment Arranging transport Negotiating time off work before invitation to screening.	Sent invitation for screening. NS (unadjusted OR 0.99, 95% CI 0.72 to 1.38)	Post	NS (unadjusted OR 0.92, 95% CI 0.68 to 1.24) However, women who made a plan to negotiate time off work were more likely to attend than those who did not or for whom planning was irrelevant ($p<0.01$)	I-I did not lead to an overall increases in attendance for breast screening.

table 1 continued overleaf...

Table 1. Included papers

Study, Year, Country, Recruitment population	*Participant demographic*	*Participant characteristics*	*Outcome and other measures*	*Intervention*	*Control*	*Method of delivery*	*Results*	*Conclusion*
Preventive healthcare service: Vaccinations								
Milkman et al, 2011 USA n=3272 Employees at a large Midwestern utility firm	Age 51.1 years ± 8.1 (mean) Gender 72.5% Male 27.5% Female Ethnicity /Race 76.6% Caucasian 20.5% African-American 2.8% Asian	Inclusion Vaccination indicated by CDC guidelines: Individuals 50 years of age or older OR Those with chronic health conditions that increase the risk of influenza related complications Time Plan Condition Control + prompt to write down date & time employees planned to get their vaccine	Outcome Influenza vaccination – receipt of a seasonal influenza vaccine at one of the firm's on-site clinics Baseline N/R	Date Plan Condition Control + prompt to write down date employees planned to get their vaccine	Info. about workplace vaccination clinics (locations & times). Info. on importance of receiving influenza vaccine. 4.2% higher vaccination rate than control – significant (unadjusted OR 1.19 95% CI 1.01 to 1.40)	Email	1.5% higher vaccination rate than control – NS (unadjusted OR 1.12, 95% CI 0.92 to 1.35)	I-I intervention significantly increased influenza vaccinations, but only when both the date & time planned.
Vet et al, 2014 Netherlands n=616 Online participants	Age 32.6 years ± 12.4 (mean) Gender 100% Male Ethnicity/Race 95% Dutch 5% Ethnic minority	Inclusion Male Had sex with a man in previous year Not infected with HBV Not previously vaccinated against HBV Didn't immediately make HBV vaccination appt online Intented to make a vaccination apt at some point	Outcome Receipt of HBV vaccine – as recorded on vaccination register Baseline - Goal intention -I-I complete -ness	Provide details of when, where & how they would make HBV vaccine appt. Either email or printed I-I given with info. about HBV vaccine sites.	General info. including contact details of Public Health Services offering HBV vaccines	Online	Strong intention more likely to have obtained HBV vaccination than men with a weak ($p<0.01$) Significant association between I-I & HBV vaccination (unadjusted OR 2.73 95% CI 1.38 to 5.4) Association between intention strength & completeness of I-I ($p<0.05$) Completeness of I-I significantly associated with HBV vaccination uptake ($p<0.001$)	Having a strong goal intention to obtain HBV vaccine and forming a complete I-I, each significantly & independently increase likelihood of MSM obtaining HBV vaccination.

table 1 continued overleaf...

...table 1 continued.

Sheeran et al., 2000 UK n=217 Patients at a single medical practice	Age 40.62 (SD=11.69) Gender 100% Female Ethnicity /Race N/R	Inclusion Due for a cervical smear test during a 3-month period	Outcome Uptake of cervical smear test Baseline -Attitudes -Subjective norms -Perceived behavioural control -Intension	Standard postal reminder to attend for cervical smear. Then a postal questionnaire on their views of cervical smear test and asked to form an I-I specifying when, where & how they would make an appointment to go for cervical smear test.	Standard postal reminder to attend for cervical smear. Then a postal questionnaire on their views of the cervical smear test.	Post	Women who formed I-I were significantly more likely to attend for their appointment (unadjusted OR 4.83, 95% CI 1.64 to 14.22)	Forming I-I to make an appointment to attend increases likelihood of attendance – even when participants strongly intend to achieve their goal.

Two studies (Greiner *et al.*, 2014; Rutter *et al.*, 2006) were deemed to be of high risk of bias, while the remaining four were of unclear risk (Appendix 3). The overall quality of evidence (as assessed by the GRADE approach) was considered to be low.

All six studies incorporated an Implementation Intention (I-I) (i.e. 'if-then' plans) component. Table 2 details the cue-automaticity component from each publication. In three studies, the 'if-then' plan was combined with other intervention components such as information about benefits of attendance for screening (Milkman *et al.*, 2011; Neter *et al.*, 2014; Greiner *et al.*, 2014). 'If' components were all personally predetermined by participants and consisted of a combination of dates, times and or places. For example, Milkman *et al.* (2011) emailed employees, at a large utility firm, one of three different emails about workplace vaccination clinics. All emails contained educational information about where and when influenza vaccinations would take place at the firm. The two intervention arms both encouraged participants, via e-mail, to construct an I-I. The first encouraged forming I-I round the date they planned to receive their vaccination, whilst the other encouraged the record of both the date and time.

The importance of full completion of the I-I (rather than partial completion) had a significant effect in two studies. Vet *et al.* (2014), recruited men online via a number of different websites for men who have sex with men (MSM). Consented participants were asked to complete online, an I-I about when, where and how to make an appointment for Hepatitis B vaccination. Those who provided a valid, registered response about when, where and how were classified as having a complete I-I. Sixty per cent of participants formed complete I-I plans and completeness was significantly associated with HBV vaccination uptake (unadjusted OR 3.64 95% CI 1.89 to 7.03). The other study, by Milkman *et al.* (2011), showed the I-I intervention significantly increased influenza vaccinations, but only in the intervention arm where both the date and the time were documented (unadjusted OR 1.19 95% CI 1.01 to 1.40).

Five studies showed a significant positive increase in preventive health service use (Table 1; Appendix 4). For example, Sheeran *et al.* (2000), who incorporated an I-I intervention at the end of a postal questionnaire around cervical cancer screening, reported 92% of interventional individuals attended for cervical cancer screening compared to 69% of controls (unadjusted OR 4.83, 95% CI 1.64 to 14.22). Neter *et al.* (2014) posted a fecal occult blood test (FOBT) kit to HMO-insured members with either an information leaflet (control) or a leaflet containing I-I instructions to write down when, where and how they would complete the FOBT test (intervention). Individuals within the intervention group were more likely to complete and return the FOBT test than controls (unadjusted OR 1.18, 95% CI 1.12 to 1.24). Another study by Greiner *et al.* (2014) incorporated, via computers within a healthcare setting (safety-nets), information and education on colorectal cancer (CRC) screening. Participants in the intervention group completed an I-I around when, where and how they would complete CRC screening, and were given a printout copy of their individualised I-I to take home. The control group were asked questions and given printout information on diet, exercise and healthy living. Individuals who completed the I-I intervention had higher odds of completing CRC screening compared to controls (AOR=1.83).

Table 2. Documentation of intervention forming cue-automaticity or link to its production

Study, Year	*Intervention details*
Vet et al, 2014	Implementation Intention (I-I) *"... The resulting increased cognitive accessibility of the specified situational cue facilitates the detection of an attention to this cue. In addition, forming an implementation intention is thought to automate the execution of a behavioural response..." pg 123*
Milkman et al, 2011	Implementation Intention (I-I) *"... Simply asking people to develop such a plan, or an "implementation intention," is all that is necessary to trigger an association between the desired behaviour and a concrete future moment..." pg 10415*
Sheeran et al, 2000	Implementation Intention (I-I) *"...Rather, "the underlying theory is that by forming implementation intentions people pass on control of goal-directed activities from the self to the environment. The intended behaviour is subject to external control through the environmental cues specified in one's implementation intention ... when these cues ... are encountered, they are expected to prompt the intended behaviour..." pg.284*
Neter et al, 2014	Implementation Intention (I-I) *"...The automation transfers goal-directed behaviour from effortful, conscious control into reacting to situational cues..." pg.274*
Rutter et al, 2006	Implementation Intention (I-I) *"... implementation intentions "pass on control of goal-directed activities from the self to the environment..." pg.128*
Greiner et al, 2014	Implementation Intention (I-I) *"...I-I can lead to initiation of action even when people are stressed..." pg. 704*

Only one of the six included studies did not show a significant intervention effect (Rutter *et al.*, 2006). This study incorporated an I-I intervention component via a postal questionnaire aimed at increasing the uptake of attendance for breast cancer screening. The I-I addressed three key barriers to attendance; namely changing an appointment, travelling to the screening unit and arranging time off work. Participants were required to form I-I for all three key barriers and return the questionnaire. Results showed a non-significant I-I intervention effect (78.9%) compared to controls (80.3%) (unadjusted OR 0.92 95% CI 0.68 to 1.24). Possible explanations for this finding could be a ceiling effect of high attendance in the control condition or because the I-Is were focused around antecedents (barriers) to the behaviour, rather than on the barrier itself.

Just one study explored the differential interventional effects of a cue-automaticity intervention by SES background. Participants in Neter *et al.* (2014) were from diverse SES backgrounds (based on clinic SES), with intervention effects consistent across the SES spectrum. In addition, Greiner *et al.* (2014) delivered the intervention to individuals from a low SES background (income >150% of the Federal Poverty Level), via recruitment from 9 different safety-net clinics within the US. They also demonstrated a positive increase in uptake of colorectal cancer screening with an I-I component (54%) compared to an education only intervention (unadjusted OR 1.18, 95% CI 1.12 to 1.24 (42%). The remaining four studies did not consider SES as an explanatory variable.

No outcome measures of automatic behaviour, such as the Self-Report Behavioural Automaticity Index (SRBAI) (Gardner et al, 2012), were reported in any of the included papers. A number of different baseline variables were measured such as: behavioural intention, self-efficacy, perceived susceptibility and perceived behavioural control. Of these variables, only intention to perform the behaviour was found to be significantly associated with intervention effectiveness (Vet al et., 2014; Neter *et al.*, 2014; Sheeran & Orbell, 2000; Rutter et al, 2006).

Discussion

The aim of this systematic review was to assess the effectiveness of interventions, containing a component of cue-automaticity, to improve the uptake of preventive healthcare, and to consider how this approach might be applied to preventive dental visiting. Given that only six studies were identified, with five of them effective, this suggests that whilst this area of research is relatively new, it may offer an effective way to improve preventive health care service uptake. An important note of caution however should be added; none of these studies were rated as high quality.

Dental visiting is an infrequent, complex behaviour. While included studies also addressed infrequent, complex behaviours such as attendance for breast cancer screening (yearly – every 3 years), influenza vaccination (yearly) and cervical cancer screening (every 3-5 years), few incorporated long term follow-up (the maximum follow-up in included studies was six months). This, therefore raises a question as to whether included interventions (all of which incorporated an I-I intervention component) can be truly seen as establishing cue-automaticity in the context of complex, infrequent health behaviours. I-I interventions, in this setting, may increase behaviour by heightening the mental accessibility of an opportune moment to act, rather than establishing a memorable link between a particular cue and behaviour (Gollwitzer & Sheeran, 2006). Therefore, the active mechanism within these interventions requires further exploration, and should include determination as to whether cue-automaticity has been established using a long term follow-up strategy. Indeed measures such as self-reported behavioural automaticity index (SRBAI) would be important to consider, as well as longer follow-up periods in future intervention work in order to help determine the level of automaticity established to predetermined cues for infrequent behaviours.

Whilst only one included study focussed on low SES participants exclusively and another explored the gradient of improvement across the SES spectrum, the impact of this type of psychological intervention across the gradient remains to be determined. However, the limited available evidence suggests that a uniform impact across the gradient may be likely (Neter *et al.*, 2014; Greiner et al 2014). This outcome will depend, however, on the extent to which full adherence to the I-I intervention is consistent across all SES groups as completeness of I-I may impact significantly on preventive behaviour.

Moreover, the intervention format of the one study where no evidence of effectiveness was found (Rutter *et al.*, 2006) suggests that I-I interventions maybe more effective when they focus on the behaviour itself rather than antecedent steps to attendance, including how one might travel to an appointment. This suggests that for dental visiting, the I-I intervention might be most effective when it documents where (i.e. which dental practice you will contact), when (i.e. which date and time you will contact with the dental practice) and how (i.e. telephone / email /face-to-face) patients will make an appointment, rather than overcoming barriers (such as arranging time off work) for dental attendance.

Certainly the infrastructure around dental appointment systems may lend itself to being used to incorporate I-I plans when making appointments for check-ups, since reminder cards and postcard messages have previously been used successfully to increase attendance (Patel *et al.*, 2000; Reekie & Devlin, 1998). The addition of an I-I intervention to the end of such reminder prompts may assist individuals with an intention to attend, by heightening their awareness to the predetermined cue associated with attendance and establishing a mental link between the specific cue and attending (Gollwitzer & Sheeran, 2006).

Finally, a number of study limitations should be acknowledged. Firstly, all of the preventive healthcare services included within the review were free for the individuals from the point of contact. Although this is true in certain situations, such as those who qualify for free dental treatment (e.g. pregnant women in the United Kingdom), treatment cost presents a substantive filter to preventive dental attendance. It is possible that this factor might prove so great a barrier as to impact on the efficacy of cue-automaticity interventions in the dental context. Secondly, preventive healthcare services within the review included cancer and Hepatitis B, which carry a significant mortality and morbidity risk. It is likely that this heightens individual's intentions to conduct this type of preventive behaviour, making this form of psychological intervention more effective. It is unclear therefore, whether this efficacy would translate into the less urgent, dental context.

Conclusion

While interventions using cue-automaticity to underpin the promotion of preventive care use are relatively rare, studies that do exist have promising results. Studies also indicate that cue-automaticity interventions in this context can be effective for low SES groups, potentially reducing health inequalities, although more work is required to explore the effect of I-I interventions that aim to establish cue-automaticity towards preventive oral health behaviour. In particular, work is required to understand the active mechanism, over the long term, of such interventions and their impact across the SES gradient.

Acknowledgments

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Appendix 4. Ethical approval documentation for study 2

NHS
Health Research Authority

NRES Committee East of England - Essex
The Old Chapel
Royal Standard Place
Nottingham
NG1 6FS

Telephone: 0115 8839695

30 March 2015

Professor Rebecca Harris
Room 113, 1st Floor, B Block, Waterhouse Building
1-5 Brownlow Street, Liverpool
L69 3GL

Dear Professor Harris

Study title:	**Developing an intervention using automated cognitive processes activated by situational features (cues) to reduce inequalities in dental preventive visiting - Phase 1**
REC reference:	**15/EE/0053**
Protocol number:	**UoL001106**
IRAS project ID:	**172681**

Thank you for your letter of , responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details. Publication will be no earlier than three months from the date of this favourable opinion letter. The expectation is that this information will be published for all studies that receive an ethical opinion but should you wish to provide a substitute contact point, wish to make a request to defer, or require further information, please contact the REC Manager, Miss Helen Poole, NRESCommittee.EastofEngland-Essex@nhs.net. Under very limited circumstances (e.g. for student research which has received an unfavourable opinion), it may be possible to grant an exemption to the publication of the study.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.

Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at http://www.rdforum.nhs.uk.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of approvals from host organisations

Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database. This should be before the first participant is recruited but no later than 6 weeks after recruitment of the first participant.

There is no requirement to separately notify the REC but you should do so at the earliest opportunity e.g. when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non-clinical trials this is not currently mandatory.

If a sponsor wishes to request a deferral for study registration within the required timeframe, they should contact hra.studyregistration@nhs.net. The expectation is that all clinical trials will be registered, however, in exceptional circumstances non registration may be permissible with prior agreement from NRES. Guidance on where to register is provided on the HRA website.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Ethical review of research sites

NHS sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	*Version*	*Date*
Copies of advertisement materials for research participants [Recruitment Poster]	2	16 February 2015
Covering letter on headed paper [Covering Letter]	1	26 January 2015
Covering letter on headed paper [Covering Letter]	2	25 March 2015
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only) [Insurance]	1	01 August 2014
Interview schedules or topic guides for participants [Topic Guide]		
Letter from funder [Letter from Funder]	1	23 October 2014
Letter from sponsor [Letter from sponsor]	1	12 January 2015
Other [REC Response]	1	16 February 2015
Other [GCP Researcher M H Mullin]	1	16 February 2015
Other [GCP Certificate]		
Other [Peer Reviewer CV]	1	25 March 2015
Participant consent form [Consent form]	1	19 November 2014
Participant information sheet (PIS) [Information Sheet]	2	16 February 2015
REC Application Form [REC_Form_29012015]		29 January 2015
Referee's report or other scientific critique report [Peer Review]	1	21 November 2014
Research protocol or project proposal [Protocol]	2.0	14 January 2015
Summary CV for Chief Investigator (CI) [CV CI]	1	29 January 2015
Summary CV for student [Student CV]	1	29 January 2015
Summary CV for supervisor (student research) [CV Supervisor]	1	29 January 2015

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document *"After ethical review – guidance for researchers"* gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The HRA website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website:
http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/

HRA Training

We are pleased to welcome researchers and R&D staff at our training days – see details at http://www.hra.nhs.uk/hra-training/

15/EE/0053	**Please quote this number on all correspondence**

With the Committee's best wishes for the success of this project.

Yours sincerely

pp

Dr Alan Lamont
Chair

Email:NRESCommittee.EastofEngland-Essex@nhs.net

Enclosures: "After ethical review – guidance for researchers"

Copy to: *Mr Alex Astor*
Ms Brenda Pinlott, Pennine Care NHS Trust

Appendix 5. Topic Guide for study 2

1. Introduction
    - Introduce researcher and study topic (including aims and objectives)
    - Confirm confidentiality, anonymity and disclosure policies
    - Explain recording (field notes and auto-tape), length of interview, reporting and data storage
    - Revisit consent (remind participant about the ability to withdraw at any time and the right not to answer all questions)
    - Ensure participant is happy to proceed
2. Background
   Aim: To familiarise participant and researcher and to gain background information about participant's current environment
    - Personal relationships
    - Household composition
    - Employment status (including working patterns, if appropriate)
    - Community activities / interests
    - Current health status
3. Tooth brushing experience
   Aim: To establish the current and past tooth brushing experience of the participant
    - Questions on how often participants brush their teeth
    - Past tooth brushing behaviours
    - Triggers for tooth brushing change
4. Cues, Rewards and Processes for regular tooth brushing
   Aim: To determine what the perceived cues, rewards and processes are for regular tooth brushing
    - Can you talk me through your tooth brushing routine?
    - Is there a behaviour in particular which comes before brushing your teeth?
    - How does brushing your teeth in the morning compare to the evening?
    - What drives you to continue to brush your teeth?
    - How do you feel if you forget to brush your teeth?
5. Future
   Aim: To find out how they see their future
    - If you could design something to help people brush their teeth, what would it look like and how could it be implemented?
6. Conclusion
   Aim: Emphasise confidentiality
    - Thank the participant
    - Reminder that confidentiality will be maintained.
    - Give contact number and e-mail address for any further follow up questions

END RECORDING
Leave copy of support leaflet on accessing dental services for the irregular dental attenders

Appendix 6. Ethical approval documentation for study 3

NHS
Health Research Authority
South Central - Oxford C Research Ethics Committee
Level 3, Block B
Whitefriars Building
Lewins Mead
Bristol
BS1 2NT

Telephone: 0207 104 8049

11 May 2016

Professor Rebecca Harris
Department of Health Services Research
Room 113, 1st Floor, Block B
Waterhouse Building, 1-5 Brownlow Street, Liverpool
L69 3GL

Dear Professor Harris

Study title: **Cross sectional survey to investigate automaticity of oral health behaviours, including tooth brushing, interdental cleaning and preventive dental attendance.**
REC reference: **16/SC/0142**
Protocol number: **UoL001194**
IRAS project ID: **196832**

Thank you for your letter of 10 May 2016. I can confirm the REC has received the documents listed below and that these comply with the approval conditions detailed in our letter dated 10 March 2016

Documents received

The documents received were as follows:

Document	*Version*	*Date*
IRAS Checklist XML [Checklist_11052016]		11 May 2016
Other [Conditions]	1	10 May 2016

Approved documents

The final list of approved documentation for the study is therefore as follows:

Document	*Version*	*Date*
IRAS Checklist XML [Checklist_11052016]		11 May 2016
Letter from sponsor [Sponsor]	1	16 February 2016
Non-validated questionnaire [Questionnaire]	1	22 February 2016
Other [GCP certificate - Mullin]	1	05 September 2014
Other [GCP Certificate - Harris]	1	05 September 2014
Other [Peer Review CV]	1	25 February 2016
Other [Conditions]	1	10 May 2016
Participant consent form [Consent form - screen shoot]	1	22 February 2016
Participant information sheet (PIS) [PIS]	2	25 February 2016
REC Application Form [REC_Form_26022016]		26 February 2016
Referee's report or other scientific critique report [Peer Review]	1	26 November 2015
Research protocol or project proposal [Protocol version 3]	3	25 November 2015
Summary CV for Chief Investigator (CI) [Signd R Harris CV]	1	25 February 2016
Summary CV for student [Signed H Raison CV]	1	22 February 2016
Summary CV for supervisor (student research) [Signed RC CV]	1	22 February 2016

You should ensure that the sponsor has a copy of the final documentation for the study. It is the sponsor's responsibility to ensure that the documentation is made available to R&D offices at all participating sites.

16/SC/0142 **Please quote this number on all correspondence**

Yours sincerely

Sadie McKeown-Keegan
REC Assistant

E-mail: nrescommittee.southcentral-oxfordc@nhs.net

Copy to: *Mr Alex Astor*
Mrs Heather Rodgers, Royal Liverpool Hospitals

Appendix 7. Cross-sectional survey questionnaire

Participant ID ☐

Age (in years) ☐

Gender ☐

Postcode ☐

Occupation ☐

UNIVERSITY OF LIVERPOOL | INSTITUTE OF PSYCHOLOGY, HEALTH AND SOCIETY

Ethnicity

- ❍ White
- ❍ Mixed or multiple ethnic groups
- ❍ Asian or Asian British
- ❍ Black or African or Caribbean or Black British
- ❍ Other (please state) _____

Highest level of education achievement

- ❍ 1-4 O levels / CSEs / GCSEs (any grade) / Entry level Foundation Diploma
- ❍ NVQ Level 1 / Foundation GNVQ /Basic Skills
- ❍ 5+ O levels (passes) / CSEs (grade 1) / GCSEs (grades A*-c) / School Certificate / 1 A-level, 2-3 AS levels / VCEs / Higher Diploma
- ❍ NVQ Level 2 / Intermediate GNVQ / City and Guilds Craft / BTEC First / General Diploma / RSA Diploma
- ❍ Apprenticeship
- ❍ 2+ A Levels / VCEs / 4+ AS levels / Higher School Certificate / Progression or Advanced Diploma
- ❍ NVQ Level 3 / Advance GNVQ / City and Guilds Advanced Craft / ONC / OND / BTEC National / RSA Advanced Diploma
- ❍ Degree (for example BA, BSc) / Higher Diploma / BTEC Higher Level
- ❍ Professional qualifications (for example teaching, nursing, accountancy)
- ❍ Other vocational / work-relation qualifications
- ❍ Foreign qualifications
- ❍ No qualifications

How often do you normally complete the following?

	Tooth Brushing	Interdental cleaning (including flossing, interdental brushes, interdens toothpick or woodstick)
	Please choose 1	Please choose 1
Never	❑	❑
Less than once a month	❑	❑
Once a month	❑	❑
Once a day	❑	❑
Twice (or more) a day	❑	❑
Other	❑	❑

Thinking about last week, how many times DID you brush your teeth?

Morning ____
Evening ____

Thinking about last week, how many times did you MISS brushing your teeth?

Morning ____
Evening ____

How often do you attend the dentist?

- ❍ Never
- ❍ Only when having trouble
- ❍ Less than every two years
- ❍ Once every two years
- ❍ Once a year
- ❍ Every 6 months
- ❍ Other (please state) _____

What is your normal reason for attendance?

- ❍ Regular dental check-up
- ❍ Occasional check-up
- ❍ Only when having pain or problems with my teeth
- ❍ Never been to the dentist
- ❍ Other (please state) _____

Deciding to brush your teeth in the MORNING is something ...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
... I do automatically	❍	❍	❍	❍	❍
... I do without having to consciously remember	❍	❍	❍	❍	❍
... I do without thinking	❍	❍	❍	❍	❍
... I do before I realise I'm doing it	❍	❍	❍	❍	❍

Brushing your teeth in the MORNING is something ...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
... I do automatically	❍	❍	❍	❍	❍
... I do without having to consciously remember	❍	❍	❍	❍	❍
... I do without thinking about what I am doing	❍	❍	❍	❍	❍
... I am doing before I realise I am doing it	❍	❍	❍	❍	❍

Deciding to brush your teeth in the EVENING is something ...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
... I do automatically	❍	❍	❍	❍	❍
... I do without having to consciously remember	❍	❍	❍	❍	❍
... I do without thinking	❍	❍	❍	❍	❍
... I do before I realise I'm doing it	❍	❍	❍	❍	❍

Brushing your teeth in the EVENING is something ...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
... I do automatically	❍	❍	❍	❍	❍
... I do without having to consciously remember	❍	❍	❍	❍	❍
... I do without thinking about what I am doing	❍	❍	❍	❍	❍
... I am doing before I realise I am doing it	❍	❍	❍	❍	❍

Deciding to interdental clean is something ... (this includes using floss, interdental brushes, woodstick or toothpicks) ...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
... I do automatically	❍	❍	❍	❍	❍
... I do without having to consciously remember	❍	❍	❍	❍	❍
... I do without thinking	❍	❍	❍	❍	❍
... I start doing before I realise I'm doing it	❍	❍	❍	❍	❍

When using interdental cleaning aids (this includes floss, interdental brushes, woodstick or toothpicks) ...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
... I do automaticially	❍	❍	❍	❍	❍
... I do without having to consciously remember	❍	❍	❍	❍	❍
... I do without thinking	❍	❍	❍	❍	❍
... I am doing it before I realise I'm doing it	❍	❍	❍	❍	❍

How motivated are you about the following?
0 = not motivation at all
50 = somewhat motivated
100 = Highly motivated

Brushing your teeth twice a day for 2 minutes ____
Floss or use interdental brushes once a day ____
Attend the dentist for a check-up ____

How strong is your goal for the following?
0 = extremely weak
100 = extremely strong

Brush your teeth twice a day for 2 minutes ____
Floss or use interdental brushes once a day ____
Attend the dentist for a check-up ____

Please select the most appropriate response

	Very un-likely	Un-likely	Somew hat likely	Un-decide d	Somew hat likely	Likely	Very likely
I intend to brush my teeth for at least 2 minutes twice a day for the next 3 months	❍	❍	❍	❍	❍	❍	❍
I intend to floss or use interdental brushes once a day for the next 3 months	❍	❍	❍	❍	❍	❍	❍
I intend to make a check-up appointment with a dentist in the next year	❍	❍	❍	❍	❍	❍	❍

How confident are you about the following?
0 = Cannot do it at all
50 = moderately can do it

100 = Highly certain can do it

Brush your teeth twice a day for 2 minutes ____

Floss or use interdental brushes once a day ____

Attend the dentist for a check-up in the next year ____

Please state how strongly you think these statements describe you

	Strongly disagree	Moderately disagree	Slightly disagree	Slightly Agree	Moderately agree	Strongly agree
It upsets me to go into a situation without knowing what I can expect from it	❍	❍	❍	❍	❍	❍
I'm not bothered by things that interrupt my daily living	❍	❍	❍	❍	❍	❍
I enjoy having a clear and structured mode of life	❍	❍	❍	❍	❍	❍
I like to have a place for everything and everything in its place	❍	❍	❍	❍	❍	❍
I enjoy being spontaneous	❍	❍	❍	❍	❍	❍
I find that a well-ordered life with regular hours makes my life tedious	❍	❍	❍	❍	❍	❍
I don't like situations that are uncertain	❍	❍	❍	❍	❍	❍
I hate to change my plans at the last minute	❍	❍	❍	❍	❍	❍
I hate to be with people who are unpredictable	❍	❍	❍	❍	❍	❍
I find that a consistent routine enables me to enjoy life more	❍	❍	❍	❍	❍	❍
I enjoy the exhilaration of being in unpredictable situations	❍	❍	❍	❍	❍	❍
I become uncomfortable when the rules in a situation are not	❍	❍	❍	❍	❍	❍

clear						

Please state how strongly you think these statements describe you

I see myself as someone who ….

	Disagree strongly	Disagree a little	Neither agree nor diagree	Agree a little	Agree strongly
... is reserved	❍	❍	❍	❍	❍
... is generally trusting	❍	❍	❍	❍	❍
... tends to be lazy	❍	❍	❍	❍	❍
... is relaxed, handles stress well	❍	❍	❍	❍	❍
... has few artistic interests	❍	❍	❍	❍	❍
...is outgoing, sociable	❍	❍	❍	❍	❍
...tends to find fault with others	❍	❍	❍	❍	❍
... does a thorough job	❍	❍	❍	❍	❍
...gets nervous easily	❍	❍	❍	❍	❍
...has an active imagination	❍	❍	❍	❍	❍

Please select which one most represents you

	Not at all like me	A little like me	Somewhat like me	Mostly like me	Very much like me
I have trouble concentrating	❍	❍	❍	❍	❍
I am able to work effectively towards long-term goals	❍	❍	❍	❍	❍
Sometimes I can't stop myself from doing something, even if I know it is wrong	❍	❍	❍	❍	❍
I often act without thinking through all the alternatives	❍	❍	❍	❍	❍

Please select which one most represents you

	Not at all like me	A little like me	Somewhat like me	Mostly like me	Very much like me
I am good at resisting temptation	❍	❍	❍	❍	❍
I have a hard time breaking bad habits	❍	❍	❍	❍	❍
I am lazy	❍	❍	❍	❍	❍
I say inappropriate things	❍	❍	❍	❍	❍
I do certain things that are bad for me, if they are fun	❍	❍	❍	❍	❍
I refuse things that are bad for me	❍	❍	❍	❍	❍
I wish I had more self-discpline	❍	❍	❍	❍	❍
People would say that I have iron self-discipline	❍	❍	❍	❍	❍
Pleasure and fun sometimes keep me from getting work done	❍	❍	❍	❍	❍

Thank you for taking the time to complete this survey. Your participation is very much appreciated.

Appendix 8. Correlation matrix to support Table 5.5

Correlations

		TB SRBAI	Motivation	Goal strength	Intention	Age	SES (Occ)	SES (Ed)	Gender	Ethnicity	Self-efficacy	Routine pref	Pers - Extra	Pers - Agree	Pers - cons	Pers-neuro	Pers - openess	Self-control
Pearson Correlation	TB_SRBAI	1.000	.264	.243	.234	.085	.027	.005	.279	.088	.343	-.006	.020	.241	.157	-.060	.101	.028
	Motivation	.264	1.000	.855	.759	-.113	-.049	.164	.288	.161	.610	.217	.152	.079	.239	-.036	-.131	.263
	Goal_Strength	.243	.855	1.000	.700	-.119	-.082	.193	.303	.166	.538	.211	.156	.179	.196	-.022	-.133	.250
	Intention	.234	.759	.700	1.000	-.181	-.051	.137	.282	.098	.669	.187	.102	.059	.206	-.006	-.148	.171
	Age	.085	-.113	-.119	-.181	1.000	.213	-.109	-.029	-.141	-.158	.063	-.054	-.082	.122	-.172	.106	.217
	SES_Occ	.027	-.049	-.082	-.051	.213	1.000	-.479	.035	-.056	-.044	.164	-.226	.026	-.154	.016	-.118	-.005
	SES_Ed	.005	.164	.193	.137	-.109	-.479	1.000	.031	.104	.117	-.197	.124	-.018	.065	-.035	.038	.048
	Gender	.279	.288	.303	.282	-.029	.035	.031	1.000	.054	.196	.311	-.051	.189	.212	.106	-.092	.146
	Ethnicity	.088	.161	.166	.098	-.141	-.056	.104	.054	1.000	.065	-.013	.108	.039	.024	-.101	-.018	.134
	Self_Eff	.343	.610	.538	.669	-.158	-.044	.117	.196	.065	1.000	.129	.131	.145	.238	.008	-.087	.148
	Routine_Pref	-.006	.217	.211	.187	.063	.164	-.197	.311	-.013	.129	1.000	-.189	-.079	.166	.315	-.031	.102
	Pers_Extra	.020	.152	.156	.102	-.054	-.226	.124	-.051	.108	.131	-.189	1.000	-.013	.121	-.147	-.034	.111
	Pers_Agree	.241	.079	.179	.059	-.082	.026	-.018	.189	.039	.145	-.079	-.013	1.000	.004	-.231	-.066	.184
	Pers_Cons	.157	.239	.196	.206	.122	-.154	.065	.212	.024	.238	.166	.121	.004	1.000	-.219	.020	.457
	Pers_Neuro	-.060	-.036	-.022	-.006	-.172	.016	-.035	.106	-.101	.008	.315	-.147	-.231	-.219	1.000	.013	-.373
	Pera_Openess	.101	-.131	-.133	-.148	.106	-.118	.038	-.092	-.018	-.087	-.031	-.034	-.066	.020	.013	1.000	-.203
	Self_Control	.028	.263	.250	.171	.217	-.005	.048	.146	.134	.148	.102	.111	.184	.457	-.373	-.203	1.000
Sig. (1-tailed)	TB_SRBAI	.	.001	.001	.002	.153	.370	.477	.000	.144	.000	.472	.404	.002	.028	.234	.112	.368
	Motivation	.001	.	.000	.000	.086	.277	.023	.000	.025	.000	.004	.032	.171	.002	.330	.057	.001
	Goal_Strength	.001	.000	.	.000	.074	.160	.009	.000	.022	.000	.005	.029	.015	.009	.394	.054	.001
	Intention	.002	.000	.000	.	.014	.270	.048	.000	.117	.000	.011	.109	.240	.006	.473	.036	.019
	Age	.153	.086	.074	.014	.	.005	.094	.365	.044	.028	.223	.258	.160	.069	.018	.099	.004

	SES_Occ	.370	.277	.160	.270	.005	.	.000	.337	.250	.297	.023	.003	.375	.031	.422	.076	.477
	SES_Ed	.477	.023	.009	.048	.094	.000	.	.356	.103	.078	.008	.067	.414	.216	.336	.325	.281
	Gender	.000	.000	.000	.000	.365	.337	.356	.	.257	.008	.000	.267	.011	.005	.100	.134	.038
	Ethnicity	.144	.025	.022	.117	.044	.250	.103	.257	.	.217	.438	.096	.321	.387	.111	.416	.052
	Self_Eff	.000	.000	.000	.000	.028	.297	.078	.008	.217	.	.059	.056	.039	.002	.462	.147	.036
	Routine_Pref	.472	.004	.005	.011	.223	.023	.008	.000	.438	.059	.	.011	.170	.022	.000	.354	.108
	Pers_Extra	.404	.032	.029	.109	.258	.003	.067	.267	.096	.056	.011	.	.436	.072	.037	.342	.090
	Pers_Agree	.002	.171	.015	.240	.160	.375	.414	.011	.321	.039	.170	.436	.	.479	.002	.212	.013
	Pers_Cons	.028	.002	.009	.006	.069	.031	.216	.005	.387	.002	.022	.072	.479	.	.004	.403	.000
	Pers_Neuro	.234	.330	.394	.473	.018	.422	.336	.100	.111	.462	.000	.037	.002	.004	.	.439	.000
	Pera_Openess	.112	.057	.054	.036	.099	.076	.325	.134	.416	.147	.354	.342	.212	.403	.439	.	.007
	Self_Control	.368	.001	.001	.019	.004	.477	.281	.038	.052	.036	.108	.090	.013	.000	.000	.007	.
N	TB_SRBAI	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Motivation	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Goal_Strength	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Intention	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Age	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	SES_Occ	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	SES_Ed	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Gender	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Ethnicity	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Self_Eff	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Routine_Pref	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Pers_Extra	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Pers_Agree	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Pers_Cons	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Pers_Neuro	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Pera_Openess	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
	Self_Control	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148

Appendix 9. Ethical Approval Documentation for Study 4A

UNIVERSITY OF LIVERPOOL

Health and Life Sciences Research Ethics Committee (Psychology, Health and Society)

15 October 2018

Dear Prof Harris

I am pleased to inform you that your application for research ethics approval has been approved. Application details and conditions of approval can be found below. Appendix A contains a list of documents approved by the Committee.

Application Details

Reference:	4022
Project Title:	A tooth brushing intervention
Principal Investigator/Supervisor:	Prof Rebecca Harris
Co-Investigator(s):	Mrs Margaret Raison, Prof Rhiannon Corcoran
Lead Student Investigator:	-
Department:	Health Services Research
Approval Date:	15/10/2018
Approval Expiry Date:	Five years from the approval date listed above

The application was **APPROVED** subject to the following conditions:

Conditions of approval

- All serious adverse events must be reported to the Committee (ethics@liverpool.ac.uk) in accordance with the procedure for reporting adverse events.
- If you wish to extend the duration of the study beyond the research ethics approval expiry date listed above, a new application should be submitted.
- If you wish to make an amendment to the study, please create and submit an amendment form using the research ethics system.
- If the named Principal Investigator or Supervisor leaves the employment of the University during the course of this approval, the approval will lapse. Therefore it will be necessary to create and submit an amendment form within the research ethics system.
- It is the responsibility of the Principal Investigator/Supervisor to inform all the investigators of the terms of the approval.

Kind regards,

Health and Life Sciences Research Ethics Committee (Psychology, Health and Society)

lphsrec@liverpool.ac.uk

0151 795 5420

Appendix - Approved Documents

(Relevant only to amendments involving changes to the study documentation)

The final document set reviewed and approved by the committee is listed below:

Document Type	File Name	Date	Version
Evidence Of Peer Review	Peer Review Assessment Form	24/07/2018	1
Participant Information Sheet	PIS V1.0 24.08.18	24/08/2018	1.0
Participant Consent Form	Consent form V1.0 24.08.18	24/08/2018	1.0
Study Proposal/Protocol	Protocol V1.0 30.8.18	30/08/2018	1.0
Interview Schedule	Topic Guide for semi	21/09/2018	1

Appendix 10. Baseline questionnaire for Study 4a

A toothbrushing intervention to establish twice daily tooth brushing

Questions to be completed by the participant

Q1 Please insert your participant ID

Q2 Please state your age in years

Q3 Please state your postcode

Q4 Please state your ethnicity

- White
- Mixed or multiple ethnic groups
- Asian or Asian British
- Black or African or Caribbean or Black British
- Other (please state)

Q5 Please state your occupation

Q6 Please state your highest level of education achievement

- 1-4 O Levels / CSEs / GCSEs (any grade) / Entry level Foundation Diploma
- NVQ Level 1 / Foundation GNVQ / Basic Skills
- 5+ O levels (passes) / CSEs (grade1) / GCSEs (grades A*-C) / School Certificate / 1 A-level, 2-3 AS levels / VCEs / Higher Diploma
- NVQ Level 2 / Intermediate GNVQ / City and Guilds Craft / BTEC First / General Diploma / RSA Diploma
- Apprenticeship
- 2+ A Levels / VCEs / 4+ AS Levels / Higher School Certificate / Progression or Advanced Diploma
- NVQ Level 3 / Advance GNVQ / City and Guilds Advanced Craft / ONC / OND / BTEC National / RSA Advanced Diploma
- Degree (for example BA, BSc) / Higher Diploma / BTEC Higher level
- Professional qualifications (for example teaching, nursing, accountancy)
- Other vocational / work-relation qualitfications
- Foreign qualifications
- No qualifications

Q7 How often do you brush your teeth?

- Twice (or more) a day
- Once a day
- Once a month
- Less than once a month
- Never
- Other (please state)

Q8 **Deciding to brush** your teeth in the **MORNING** is something ..

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
... I do automatically					
... I do without having to consciously remember					
... I do without thinking					
...I do before I realise I'm doing it					

Q9 **Brushing** your teeth in the **MORNING** is something...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
... I do automatically					
... I do without having to consciously remember					
...I do without thinking					
... I do before I realise I'm doing it					

Q10 **Deciding to brush** your teeth in the **EVENING** is something ...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
...I do automatically					
... I do without having to consciously remember					
...I do without thinking					
...I do before I realise I'm doing it					

Q11 **Brushing your teeth** in the **EVENING** is something ...

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
...I do automatically	○	○	○	○	○
... I do without having to consciously remember	○	○	○	○	○
...I do without thinking	○	○	○	○	○
... I do before I realise I'm doing it	○	○	○	○	○

Q12 How motivated are you to brushing your teeth twice a day?

- ○ Not motivation at all
- ○ Motivated a little
- ○ Somewhat motivated
- ○ Motivated
- ○ Highly motivated

Q13 Please click the most appropriate response.

I intend to brush my teeth for at least 2 minutes twice a day for the next 3 months.

- ○ Very unlikely
- ○ Unlikely
- ○ Somewhat unlikely
- ○ Undecided
- ○ Somewhat likely
- ○ Likely
- ○ Very likely

Q14 How confident are you that you can brush your teeth twice a day for 2 minutes for the next 3 months?

- ○ Cannot do it at all
- ○ Can do a little
- ○ Moderately can do
- ○ Certain can do
- ○ Highly certain can do

Thank you for taking the time to complete the questionnaire. Your participant is very much appreciated.

Questions to be completed by the researcher when the participant has left

Q15 New tooth brushing behaviour to be established ...

- ...at night
- ...in the morning
- Other

Q16 Identified preceding cue for new tooth brushing behaviour

Q17 Participants routinised behaviour on post it notes looked like this

Appendix 11. Ethical approval documentation for study 4B

NHS
Health Research Authority
London - Dulwich Research Ethics Committee
Health Research Authority
Skipton House
80 London Road
London
SE1 6LH

Please note: This is the favourable opinion of the REC only and does not allow the amendment to be implemented at NHS sites in England until the outcome of the HRA assessment has been confirmed.

05 September 2017

Mrs Heather Ralson
Department of Health Services Research
University of Liverpool, Room 111, 1st Floor, B Block
Waterhouse Building, 1-5 Brownlow Street, Liverpool
L69 3GL

Dear Mrs Ralson

Study title:	**A toothbrushing intervention for pregnant women based on habit formation theory**
REC reference:	**17/LO/0696**
Protocol number:	**UoL001284**
Amendment number:	**1**
Amendment date:	**10 July 2017**
IRAS project ID:	**221041**

The above amendment was reviewed at the meeting of the Sub-Committee held in correspondence.

Ethical opinion

The Sub-Committee noted that participants should initial boxes the consent form and not tick them as per the standard template and they also asked for other grammatical changes.

On the PIS, the Sub-Committee asked for the sentence "We want to deliver a toothbrushing intervention (tool) to help pregnant women brush their teeth twice a day as a habit" to be explained further. The PIS stated "and brush your teeth at least once a day", which was inconsistent with the protocol which says: Inclusion criteria for stage 2 will include pregnant women who brush their teeth less than once a day (i.e. once a day brushers, or those who do not brush their teeth). It was also noted that the PIS states "However, interviews (part 2) can take place in your choice of café, where a drink and snack will be paid for you." This was inconsistent with protocol which states that interviews can be conducted either in person or by telephone. The Sub-Committee wanted to know if the participant choses to have an interview in-person would this take place in their community clinic (confidential) or other preferred public location. The Sub-Committee wanted to confirm that there was a lone worker policy in place and asked for the inconsistencies to be corrected.

The Sub-Committee asked for PIS to explain what the intervention (tool) might entail, to include the duration of the interview and to explain who the focus groups are, since this study involves 1:1 interviews. They also asked for the PIS to include the REC name, PALS or a similar organisations contact details and to explain how the study outcomes will be made available to the participants.

The members of the Committee taking part in the review gave a favourable ethical opinion of the amendment on the basis described in the notice of amendment form and supporting documentation.

Approved documents

The documents reviewed and approved at the meeting were:

Document	*Version*	*Date*
Notice of Substantial Amendment (non-CTIMP)	1	10 July 2017
Participant consent form [Stage 2 - tracked]	3	04 September 2017
Participant information sheet (PIS) [Stage 2 - tracked]	3	04 September 2017
Research protocol or project proposal	5	10 July 2017

Membership of the Committee

The members of the Committee who took part in the review are listed on the attached sheet.

Working with NHS Care Organisations

Sponsors should ensure that they notify the R&D office for the relevant NHS care organisation of this amendment in line with the terms detailed in the categorisation email issued by the lead nation for the study.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

We are pleased to welcome researchers and R & D staff at our Research Ethics Committee members' training days – see details at http://www.hra.nhs.uk/hra-training/

Yours sincerely

PP
Dr Michael Philpot
Chair

E-mail: nrescommittee.london-dulwich@nhs.net

Enclosures: *List of names and professions of members who took part in the review*

Copy to: *Ms Louise Hardman, Liverpool Women's NHS Foundation Trust*
Mrs Heather Raison

London - Dulwich Research Ethics Committee

Attendance at Sub-Committee of the REC meeting in correspondence

Committee Members:

Name	*Profession*	*Present*	*Notes*
Dr Martin Keech	Clinical Project Manager	Yes	
Dr Michael Philpot	Consultant Psychiatrist	Yes	

Also in attendance:

Name	*Position (or reason for attending)*
Ms Asha Jama	REC Assistant

Appendix 12. Topic Guide for Focus Group for Study 4B

1. Introduction
    - Introduce researcher and study topic (including aims and objections)
    - Confirm confidentiality, anonymity and disclosure policies
    - Explain recording, 'focus group ground rules' i.e. that differing opinions are to be nurtured, that it is helpful to allow other to finish talking before speaking, in order to allow for accurate transcription
    - Ensure all participants are happy to proceed
    - Ask each member of the group to introduce themselves – ice breaker
    - Group participation task – habit formation using post-it notes as visualisation tool

2. Toothbrushing in pregnancy
   Aim: To establish what the general attitudes are towards the research idea, and how best to approach pregnant women with it.
    - Attitudes towards the general need of the research topic i.e. is it of value to the women, how receptive the women would be to learning about oral health during antenatal appointments
    - How should the topic be broached with women i.e. how they would feel if they were asked oral health questions such as 'how many times do they brush their teeth'
    - How should eligibility screening be approached: exploring self-report measures, how it should be approached to gather the most accurate results from participants
    - Barriers and facilitators to recruitment

3. The Intervention
   Aim: To find out how the intervention would be received and to further develop the intervention idea for use in the Stage 2
    - Researcher to demonstrate the intervention to the group, using joint group ideas to make the intervention outline (using post-it notes as a visualisation tool)
    - Feasibility of the intervention concept
    - Timing of intervention delivery i.e. where in the appointment booking should this be delivered
    - Location of the intervention delivery
    - Format of the intervention delivery i.e. a computerised task, face-to-face etc
    - Appropriate content of the intervention
    - General comments
4. Conclusion
   Aim: Emphasise confidentiality
    - Thank the participant
    - Reminder that confidentiality will be maintained.
    - Give contact number and e-mail address for any further follow up questions

END OF SESSION

Appendix 13. Topic Guide for stage 2 semi-structured interviews for study 4B

1. Introduction
    - Introduce researcher and study topic (including aims and objectives)
    - Confirm confidentiality, anonymity and disclosure policies
    - Explain recording (field notes and auto-tape), length of interview, reporting and data storage
    - Revisit consent (remind participant about the ability to withdraw at any time and the right not to answer all questions)
    - Ensure participant is happy to proceed
2. Background
   Aim: To familiarise participant and researcher and to gain background information about participant's current lifestyle e.g. social networks/hobbies
    a. Current stage of pregnancy and any pregnancy issues
    b. Employment status (including working patterns, if appropriate)
    c. General interests / social networks
3. Intervention
   Aim: To establish if twice daily habitual tooth brushing behaviour has been established following up intervention delivery
    a. Current tooth brushing patterns
    b. The effect of the intervention in changing these patterns or reasons why tooth brushing behaviour has remained unchanged
    c. Issues or struggles with the implementation of the intervention
    d. Usefulness of the implementation intention credit card (i.e. did this successful act as a reminder prompt?)
4. Impact of intervention on other oral health behaviour of participants and other members of the family unit
   Aim: To determine if the intervention has made a positive impact on other oral health behaviours
    a. Has participant's interdental cleaning, mouthwash or dental visiting pattern changed since the intervention
    b. Have other behaviours of the participant been affected by the intervention i.e. healthy eating, reduced sugar consumption
    c. Has the intervention caused any changes in the oral health behaviour of other members of family unit or individuals who live under the same roof as the participant
5. Future
   Aim: To find out how they see the intervention being most effective in the future
    a. If participant could alter the design of the intervention, what would this include and why?
6. Conclusion
   Aim: Emphasise confidentiality
    - Thank the participant
    - Reminder that confidentiality will be maintained.
    - Give contact number and e-mail address for any further follow up questions

END RECORDING